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TESTING SUCTION GAS PRODUCERS WITH A KOERTING EJECTOR

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Non-Member

The method of testing the suction gas producer herein described, and the forms for computation given in the Appendix to the paper, have been used by the writers to advantage in their gas-producer tests in the mechanical engineering laboratory of the University of Illinois. The method of testing has reduced the labor of running such tests to a minimum, and the forms for computation have greatly reduced the labor and tedium of the calculations.

2 The tests were made on an Otto suction gas producer rated at 60 h.p. and 8000 cu. ft. of gas per hour. The plant as originally installed consisted of the producer *A* (Fig. 1), the wet scrubber *B*, the gas receiver *C*, and a 22-h.p. engine. In order to facilitate the testing of the plant the connection to the 22-h.p. engine was blanked and a Schutte-Koerting steam ejector of 12,000 cu. ft. hourly capacity was placed in the gas main at *F*. This ejector was used to draw the gases from the producer and deliver them to the wet scrubber *G*, where the steam used by the ejector was condensed.

3 The condensed steam and condensing water passed out at the overflow, *M*, while the gases passed out through the separator *N* and into the dryer *H*, constructed from a gas bell, or holder, and filled with straw, and used to separate the suspended moisture from the gases before they entered the meters *I* and *J*. The meters were of 8000 and 3500 cu. ft. hourly capacity respectively, and were connected in parallel for capacities greater than 8000 cu. ft. per hour, the larger meter alone being used for lower capacities. From the meters the

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All papers are subject to revision.

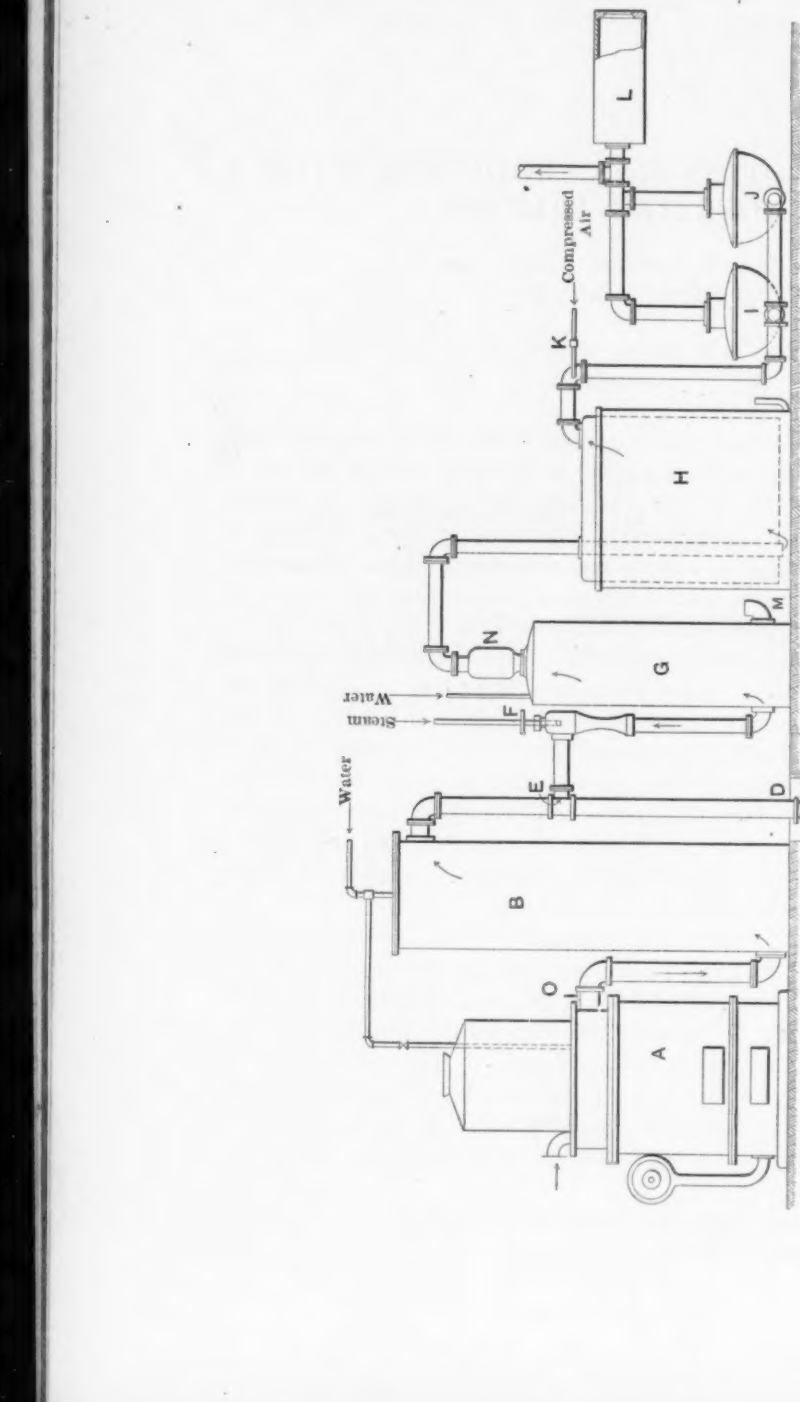


Fig. 1 General Arrangement of Suction Gas Producer Plant Tested with Koerting Ejector

gases were discharged into the atmosphere above the roof of the laboratory.

4 A gage box L was adapted to receive thin plates with orifices, and was used in calibrating the meters, by means of air. The meters having been blanked from the gas main, compressed air was admitted at K, and expanding passed through the meter to be calibrated and out at the orifice in L. The data for the orifice was taken from the paper by R. J. Durley, in Vol. 27, 1906, of the Transactions. After the calibration, the inlet to the box was blanked.

5 The producer is of the contained vaporizer type, with grate and without charging bell, the specifications stating that it is only to be used twelve hours at a time. During some of the earlier tests the cast-iron vaporizer was cracked. A steam jet was then used to supply the moisture, and the vaporizer was blanked off. The weight of steam was measured by passing the jet through a calibrated orifice in a thin plate.

TABLE 1 TEMPERATURES IN FUEL BED

Time	Zone No.	Temp. 3 in. from Near Wall F°	Temp. at Center, F°	Temp. 3 in. from Far Wall F°
10:05–10:10 a.m.	1	2100	2037	2025
10:25–10:30	2	2350	2225	2275
10:43–10:55	3		2200	2400

6 The test was started with the producer full and with a clean fuel bed. The coal fired during the test was weighed and at the end of the test the fire was cleaned, the fuel bed being brought to as near the starting condition as possible, and the producer filled. In order that the error in determining the weight of coal fired in this manner might be known, the producer when cold was filled a number of times, and the weight of coal required was noted. The average of these weights was taken to be the true weight of coal required to fill the producer, the probable error in filling with a given weight of coal being estimated from these results. In running it was endeavored to make the tests of such duration as to bring the probable error of filling down to about two or three per cent.

7 The temperature of the gas leaving the producer was taken at O by means of a platinum-rhodium thermo-couple and a Siemens & Halske milivoltmeter, calibrated to read direct in degrees centigrade.

The temperatures in the fuel bed were taken with Hoskins thermocouples and galvanometer, the latter reading in degrees fahr. Other temperatures were taken with mercury thermometers.

8 The temperatures in the fuel bed were taken in three horizontal zones 10 in., 18 in., and 24 in., respectively, above the grate. In each zone readings were taken 3 in. from the lining on each side, and in the center of the fuel bed. The results are given in Table 1.

9 By means of the sampling tube illustrated in Fig. 2, samples of gas were taken continuously for test by a Junkers calorimeter and for

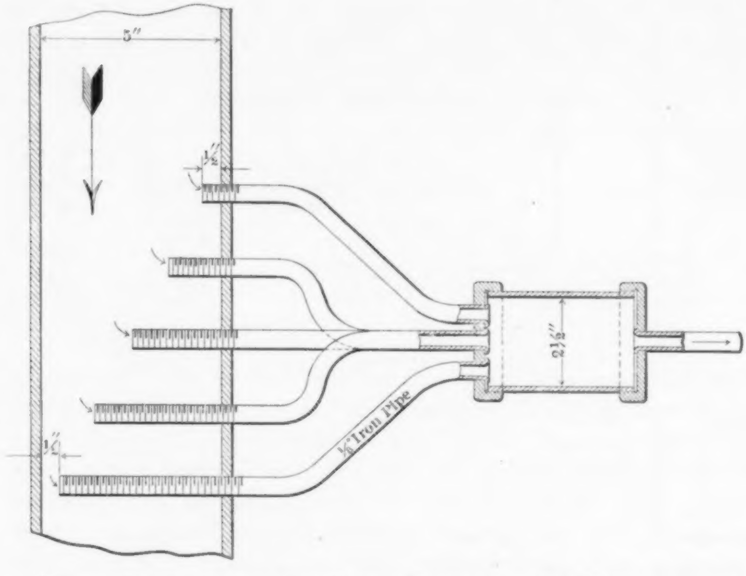


FIG. 2 SAMPLING TUBE FOR TAKING SAMPLES OF GAS CONTINUOUSLY

analysis, by Hempel apparatus. The results of the analyses are given in Table 2.

10 As already stated, the weight of steam fed to the producer was determined by the use of a calibrated orifice. By means of a small laboratory aspirator, a sample of the gas leaving the producer was drawn successively through a calcium chloride tube and a small gas meter, the weight of moisture being determined by the calcium chloride tube and the volume by the meter. The per cent of moisture determined by this method was used merely as a check, the percent-

age used in the computations being obtained by calculating the weight of water decomposed from the analysis of the gases and the analysis of the fuel. The difference between this quantity and the total weight of moisture carried into the producer, gives the weight of the moisture in the gas leaving the producer.

11 The volume of gas generated by the producer, and measured by the meters, was also checked by computing the volume of the gas generated from the analyses of gas and coal. In the anthracite producer, where the loss of carbon in soot and tar is small, probably not over 1 per cent, this offers an excellent means of checking the gas volume, and also of computing the weight of air used. The gas analysis, where continuous samples are taken by the form of sampling tube illustrated, should be accurate within 1 per cent. The greatest error is likely to be made in the sampling of the coal. With a fine coal,

TABLE 2 GAS ANAYLSIS BY VOLUME

No.	Time	Per Cent CO_2	Per Cent O_2	Per Cent CO	Per Cent CH_4	Per Cent H_2	Per Cent N_2	B.T.U.
1	6:23– 9:05 a.m.	5.7	0.5	22.9	2.1	12.2	56.6	134
2	9:10–10:37	4.1	0.2	27.9	1.6	11.1	55.1	142
3	10:39–12:25 p.m.	3.3	0.1	28.4	1.5	9.5	57.2	137
4	12:30– 2:52	4.3	0.2	26.9	1.8	10.6	56.2	139
5	3:00– 4:35	3.6	0.1	28.6	1.8	9.0	56.9	139
6	4:40– 6:05	4.1	0.3	27.4	1.8	10.0	56.4	138
Average		4.20	0.23	27.01	1.77	10.40	56.40	138.1

such as pea or buckwheat, and a sample representing from 10 to 20 per cent of the total weight of coal fired, the error in sampling should not exceed 2 per cent. The maximum error in determining the gas volume and the weight of air used should not exceed 5 per cent, if the error in filling the producer is 2 per cent. The probable error is therefore much less. In most of the tests, the volume of gas computed from analysis has checked within 5 per cent the volume determined by the meters. The meters are known to be accurate well within 2 per cent.

12 In the testing of large producers of the bituminous type, it is often difficult to measure the gas volume by any mechanical means. In such cases, if the carbon lost in the soot and tar is estimated from a sample of the soot and tar, and this amount deducted from the total weight of carbon in the coal, the volume may then be computed from

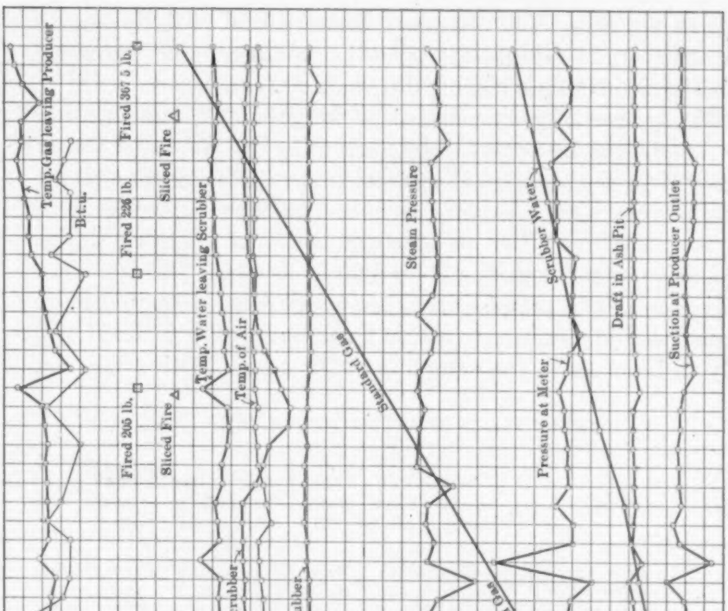


FIG. 3 GRAPHICAL LOG OF TEST OF SUCTION GAS PRODUCER

the analyses of the gas and coal, and may be relied upon within 5 per cent, provided the sampling is accurate.

13 In order to facilitate computations, we have prepared three separate forms, or rather two forms and a guide sheet. Form 1 is used only for the presentation of the results of the tests. Form 2 contains all items used in the computations, while Form 3 is the guide sheet containing all of the formulae and their derivation. The items of Form 3 are arranged in the order of computation. In following out this method, the average corrected quantities are taken from the original data sheets and placed on Form 2. The computations are then made by following Form 3. After Form 2 is completed, the results are transferred to Form 1.

14 Referring to Form 1, Item 46, it will be noted that the total ash and refuse is much less than the weight of ash alone that would be obtained by computing from the analysis. This is due to the difficulty in cleaning the ash out of the fuel bed, and partly to the loss of ash in the form of dust, which is carried over into the scrubber. In this particular coal, which had very little tendency to clinker, the ash was soft and fine so that it packed in and filled the interstices between the live coals. A small amount of clinker was formed on the sides.

15 This tendency of the ash to pack in the fuel bed, while it prevents the accurate determination of the actual weight of ash, does not, it is believed, materially affect the determination of the weight of coal as fired, for the reason just given; that is, while the fuel bed may contain as much carbon at the start as at the close, the bed is much more compact due to the ash. The weight of ash and refuse is valuable principally for the determination of the unburned carbon lost through the grate.

16 Item 66, dry coal per sq. ft. of grate area per hour, is high; while the producer was operating only at about 4800 cu. ft. per hour capacity, this was considerably above its actual capacity. If the fuel had contained a fusible ash the results as shown on Form 1 and the graphical log Fig. 3 would have been practically impossible.

17 The heat balance, Form 1, shows the unaccounted-for loss to be 4.4 per cent. This includes radiation and conduction, which for this test probably amounts to between 2 and 3 per cent. By referring to Form 2, Item 126, it will be seen that the volume of standard gas, computed from the analysis of the gas and the analysis of the coal, checks within about 2.3 per cent of the volume of standard gas as given by the meters, Item 125.

18 The graphical log sheet Fig. 3 illustrates the uniformity of conditions that were maintained throughout the test.

19 Permission for running the producer tests was obtained through Prof. L. P. Breckenridge, the results being presented through the courtesy of Dean W. F. M. Goss, of the University of Illinois.

APPENDIX

FORM 1 RESULTS OF GAS PRODUCER TRIALS

1	Test number	25
2	Made by........C. M. Garland and A. P. Kratz	
3	At........The University of Illinois	
4	Kind of producer........Otto	
5	To determine........Efficiency	
6	Principal conditions governing trial.....Uniform load	
7	Kind of fuel........Scranton-Anthracite	
8	Kind of grate........Plain	
9	Method of starting and stopping test.....Alternate	
10	Type of producer........Suction	
11	Form of blower-ejector......Schutte & Koerting	
12	Date of trial	5-29-1909
13	Duration of trial	12 hr.

DIMENSIONS AND PROPORTIONS

14	Dimensions of grate, ft	1.25 by 1.33
15	Grate area, sq. ft	1.666
16	Mean diameter of fuel bed, ft	1.545
17	Depth of fuel bed, ft	2.21
18	Area of fuel bed, sq. ft	1.877
19	Height of discharge pipe above grate, ft	2.875
20	Approximate width of air spaces in grate, inches	0.5
21	Area of air space, sq. ft	0.722
22	Proportion of air space to whole grate area, per cent	43.3
23	Area of discharge pipe, sq. ft	0.165
24	Water heating surface in vaporizer, sq. ft	
25	Outside diameter of shell, ft	2.833
26	Length of shell from base to top of magazine, ft	7.125
27	Ratio of water heating surface to grate area, — to 1	
28	Ratio of minimum draft area to grate area, 1 to	48.8

AVERAGE PRESSURES

29	Draft in ashpit, inches, water	0.61
30	Suction at producer outlet, inches, water	2.04
31	Pressure at meters, inches, water	3.76
32	Corrected barometer reading	29.15
32.1	Steam pressure, lb. per sq. in. gage	90.5

AVERAGE TEMPERATURES

33	Of fire room, deg. fahr.	82.2
34	Of steam leaving vaporizer, deg. fahr.	212
35	Of feed water entering vaporizer, deg. fahr.	
36	Of overflow from vaporizer, deg. fahr.	212
37	Of water entering scrubber, deg. fahr.	57.8
38	Of water leaving scrubber, deg. fahr.	103.6
39	Of gases leaving producer, deg. fahr.	1108
40	Of gases leaving scrubber, deg. fahr.	84.3
41	Of gases entering meter, deg. fahr.	68.0

FUEL

42	Size and condition ... Pea–Clean	
43	Weight of coal as fired, lb.	798.5
44	Percentage of moisture in coal.	2.75
45	Total weight of dry coal fired, lb.	776.5
46	Total ash and refuse, lb.	85.0
47	Quality of ash and refuse.	
48	Total combustible consumed, lb.	614
49	Percentage of ash and refuse in dry coal	10.9

PROXIMATE ANALYSIS OF COAL

50	Fixed carbon.	78.45
51	Volatile matter	5.99
52	Moisture.	2.75
53	Ash.	12.81
54	Sulphur, separately determined.	1.10

ULTIMATE ANALYSIS OF DRY COAL

55	Carbon, C.	79.84
56	Hydrogen, H_2	2.67
57	Oxygen, O_2.	2.37
58	Nitrogen, N_2.	0.82
59	Sulphur, S.	1.13
60	Ash.	13.17
61	Moisture in sample of coal as received.	2.75

ANALYSIS OF DRY COAL AND REFUSE

62	Carbon, per cent.	38.80
63	Earthy matter, per cent.	61.20
	a SiO.	
	b { Al_2O_3.	
	Fe_2O_3.	
	c MgO.	
	d CaO.	

FUEL PER HOUR

64	Dry coal fired per hr. lb	64.7
65	Combustible consumed per hour, lb	51.2
66	Dry coal per sq. ft. of grate area per hr. lb	38.8
67	Combustible per sq. ft. of grate area per hr. lb	30.7
68	Dry coal per sq. ft. of fuel bed per hr. lb	34.5
69	Combustible per sq. ft. of fuel bed per hr. lb	27.3
70	Rate of descent of dry coal through fuel bed, lb. per ft. per sq. ft. per hr	15.6
71	Rate of descent of combustible through fuel bed, lb. per ft. per sq. ft. per hr	12.4

CALORIFIC VALUE OF FUEL

72	Calorific value by oxygen calorimeter per lb. dry coal, B.t.u..	13040
73	Calorific value by oxygen calorimeter per lb. of combustible B.t.u	15700
74	Calorific value by analysis per lb. dry coal, B.t.u	13125
75	Calorific value by analysis per lb. of combustible, B.t.u	15800

WATER

76	Total[1] weight of water fed to vaporizer, lb	267.8
77	Total weight of overflow from vaporizer, lb	0.0
78	Water[1] actually evaporated in vaporizer, lb	267.8
79	Total weight of water fed to producer, lb	341.5
	a From vaporizer[1]	267.8
	b In air	51.7
	c In coal	22.0
80	Total weight of water decomposed	218.2
81	Total weight of water in gas leaving producer, lb	123.3
82	Ratio of water decomposed to water supplied	0.639
83	Weight of water decomposed per lb. gas generated, lb	0.0558
84	Weight of water decomposed per lb. of dry coal fired, lb	0.281
85	Weight of water decomposed per lb. of combustible consumed, lb	0.355
86	Weight of water decomposed per lb. of air supplied, lb	0.0702
87	Weight of water supplied per lb. of dry coal fired, lb	0.440
88	Weight of water supplied per lb. of combustible consumed, lb.	0.556
89	Weight of water supplied per lb. of dry air used, lb	0.1097
90	Total weight of scrubber water, lb	22200

WATER PER HOUR

91	Water evaporated per hr. in vaporizer, lb	
92	Water evaporated per hr. per sq. ft. of water heating surface in vaporizer, lb	
93	Weight of water decomposed per hr., lb	18.2

[1] Steam fed to vaporizer

94	Total weight of water fed to producer per hr., lb	28.5
95	Weight of scrubber water used per hr., lb	1850.0

QUANTITY OF AIR

96	Per cent of moisture in air, per cent of dry air	1.66
97	Total weight of dry air, lb	3112.
98	Total weight of dry air per hr. lb	259.2
99	Weight of dry air used per lb. of dry coal fired, lb	4.01
100	Weight of dry air used per lb. of combustible consumed, lb	5.07
101	Weight of dry air used per lb. of dry gas generated, lb	0.796

GAS

102	Per cent moisture in gas leaving producer, per cent of dry gas	3.15
103	Per cent of soot and tar in gas leaving producer	
104	Calorific value of standard gas from analysis (high value) B.t.u. per cu. ft	138.1
105	Calorific value of standard gas from calorimeter, (high value) B.t.u. per cu. ft	137.3
106	Specific weight of standard gas, lb. per cu. ft	0.0680
107	Specific heat of dry gas leaving producer	0.3281
108	Carbon ratio C/H	14.07
109	Total volume standard gas, cu. ft	57500.
110	Volume of standard gas per hr. cu. ft	4795.
111	Volume of standard gas per lb. of dry coal	74.1
112	Volume of standard gas per lb. of combustible	93.7
113	Total weight of standard gas, lb	3912
114	Weight of standard gas per hr., lb	326
115	Weight of standard gas per lb. of dry coal fired, lb	5.03
116	Weight of standard gas per lb. of combustible consumed, lb	6.37

GAS ANALYSIS BY VOLUME

117	Carbon dioxide, CO_2	4.20
118	Carbon monoxide, CO	27.01
119	Oxygen, O_2	0.23
120	Hydrogen, H_2	10.40
121	Marsh gas, CH_4	1.77
122	Olefiant gas, C_2H_4	
123	Sulphur dioxide, SO_2	
124	Hydrogen sulphide, H_2S	
125	Nitrogen, N_2, by difference	56.40

EFFICIENCY

126	Grate efficiency, per cent	95.3
127	Hot gas efficiency, based on high heating value, per cent	90.9
128	Cold gas efficiency, based on high heating value, per cent	78.3

EFFICIENCY BASED ON COMBUSTIBLE

128*a*	Hot gas efficiency, based on high heating value	95.4
128*b*	Cold gas efficiency, based on high heating value	82.2

COST OF GASIFICATION

129	Cost of fuel per ton delivered in producer room	
130	Cost per 1000 cu. ft. of standard gas, cents	
131	Cu. ft. scrubber water per 1000 cu. ft. gas	6.18

POKING

132	Method of poking..........From top, slicing from bottom	
133	Frequency of poking............Three times during run	

FIRING

134	Method of firing..........Hand	
135	Average intervals between firing.......Twice during run	
136	Average amount of fuel charged each time, lb	250

HEAT BALANCE

Debit	B.t.u.	
a Total heat supplied per lb. dry coal	13040	
b Total heat supplied by air per lb. dry coal	19	
c Total heat supplied by moisture in air per lb. dry coal		
d Total heat supplied by moisture in coal per lb. dry coal		
e Total heat supplied as sensible heat in coal per lb. dry coal		
f Total[1] heat supplied by water in vaporizer per lb. dry coal	385	
Total	13444	
Credit	**B.t.u.**	**Per Cent**
a Heat contained as sensible heat in dry gas	1725	12.8
b Heat contained in moisture	262	2.0
c Heat contained in dry gas (heat of combustion)	10240	76.2
d Heat in unburned carbon	618	4.6
e Heat contained in ash and refuse as sensible heat		
f Heat lost in overflow from vaporizer		
g Heat lost in radiation and conduction	599	4.4
Total	13444	100.0

[1] Supplied in steam.

FORM No. 2 RESULTS OF GAS PRODUCER TRIALS

NO. OF TEST 25. DATE, 5/29/09. TIME OF START 6.15 A.M.
TIME OF STOP 6.15 P.M. DURATION OF TRIAL, 12 HRS. KIND OF FUEL
SCRANTON-ANTHRACITE

DIMENSIONS AND PROPORTIONS

1	Dimensions of grate, ft.	1.25 by 1.33
2	Grate area, sq. ft.	1.666
3	Mean diameter of fuel bed, ft.	1.545
4	Depth of fuel bed, ft.	2.21
5	Area of fuel bed, sq. ft.	1.877
6	Height of discharge pipe above grate, ft.	2.875
7	Approximate width of air spaces in grate, inches	0.5
8	Area of air space, sq. ft.	0.722
9	Ratio of air space to whole grate area	1 to 2.3
10	Area of discharge pipe, sq. ft.	0.165
11	Water heating surface in vaporizer, sq. ft.	
12	Outside diameter of shell, ft.	2.833
13	Length of shell from base to top of magazine, ft.	7.125
14	Ratio of water heating surface to grate area — to 1	
15	Ratio of minimum draft area to grate area	1 to 48.8

AVERAGE PRESSURES

16	Average barometer reading, inches Hg.	29.258
17	Average corrected barometer reading, inches Hg.	29.152
18	Draft in ash pit, inches water	0.61
19	Suction at producer outlet, inches water	2.04
20	Absolute pressure at producer outlet, inches Hg.	29.00
21	Suction[1] at orifice, inches water	90.5
22	Absolute pressure[1] at orifice, inches Hg.	104.8
23	Pressure at meters, inches water	3.76
24	Absolute pressure at meters, inches Hg.	29.43
25	Vapor pressure at meters, inches Hg.	0.685
26	Dry gas pressure at meters, inches Hg.	28.75
27	Suction at meter for dryer, inches water	2.04
28	Absolute pressure at meter for dryer, inches Hg.	29.00

AVERAGE TEMPERATURES

29	At barometer, deg. fahr.	78.0
30	Of fire room, deg. fahr.	82.2
31	Of fire room, deg. absolute fahr.	542.2
32	Of steam, deg. fahr.	212
33	Of feed water entering vaporizer, deg. fahr.	
34	Overflow from vaporizer, deg. fahr.	212
35	Rise in vaporizer, deg. fahr.	

[1]Steam pressure

36	Of water entering scrubber, deg. fahr	57.8
37	Of water leaving scrubber, deg. fahr	103.6
38	Rise in scrubber, deg. fahr	45.8
39	Of gases leaving producer, deg. fahr	1108
40	Of gases leaving producer, deg. abs. fahr	1568
41	Of gases leaving first scrubber, deg. fahr	84.3
42	Of gases leaving first scrubber, deg. abs. fahr	544.3
43	Drop in temperature of gases in scrubber, deg. fahr	1023.7
44	Of gases entering meters, deg. fahr	68.0
45	Of gases entering meters, deg. abs. fahr	528
46	Of gas at meter at dryer, deg. fahr	80.0
47	Of gas at meter at dryer, deg. abs. fahr	540

FUEL

48	Size and condition . . . Pea, Clean	
49	Weight of coal as fired, lb	798.5
50	Percentage of moisture in coal	2.75
51	Total weight of dry coal fired, lb	776.5
52	Total ash and refuse, lb	85.0
53	Quality of ash and refuse	
54	Total weight of combustible, lb	614
55	Percentage of ash and refuse in dry coal, per cent	10.9

PROXIMATE ANALYSIS OF COAL

56	Fixed carbon, per cent	78.45
57	Volatile matter, per cent	5.99
58	Moisture, per cent	2.75
59	Ash, per cent	12.81
60	Sulphur, separately determined, per cent	1.10

ULTIMATE ANALYSIS OF DRY COAL

61	Carbon, C, per cent	79.84
62	Hydrogn, H_2, per cent	2.67
63	Oxygen, O_2, per cent	2.37
64	Nitrogen, N_2, per cent	0.82
65	Sulphur, S, per cent	1.13
66	Ash, per cent	13.17
67	Moisture in sample of coal as received, per cent	2.75

ANALYSIS OF DRY ASH AND REFUSE

68	Carbon, per cent	38.80
69	Earthy matter, per cent	61.20
	a SiO_2	
	b $\left\{ \begin{array}{l} Al_2O_3 \\ Fe_2O_3 \end{array} \right.$	
	c MgO	
	d CaO	

FUEL PER HOUR

70	Dry coal fired per hr., lb.	64.7
71	Combustible consumed per hr., lb.	51.2
72	Dry coal sq. ft. of grate area per hr., lb.	38.8
73	Combustible per sq. ft. of grate area per hr., lb.	30.7
74	Dry coal per sq. ft. of fuel bed per hr., lb.	34.5
75	Combustible per sq. ft. of fuel bed per hr., lb.	27.3
76	Rate of descent of dry coal through fuel bed, lb. per ft. per sq. ft. per hr.	15.6
77	Rate of descent of combustible through fuel bed, lb. per ft. per sq. ft. per hr.	12.4

CALORIFIC VALUE OF FUEL

78	Calorific value by oxygen calorimeter per lb. dry coal, B.t.u.	13040
79	Calorific value by oxygen calorimeter per lb. combustible, B.t.u.	15700
80	Calorific value by analysis, per lb. dry coal, B.t.u.	13125
81	Calorific value by analysis, per lb. combustible, B.t.u.	15800

WATER

82	Total[1] weight fed to vaporizer, lb.		267.8
83	Total weight of overflow, lb.		0.0
84	Water[1] actually evaporated in vaporizer, b.		267.8
85	Weight of water fed to producer,		
	a From vaporizer[1]	267.8	
	b In air	51.7	
	c In coal	22.0	
	Total		341.5
86	Total weight of water decomposed from analysis, lb.		218.2
87	Total weight of water decomposed as used in calculations, lb.		218.2
88	Total weight of moisture in gas leaving producer, lb.		123.3
89	Ratio of water decomposed to water supplied		0.639
90	Weight of water decomposed per lb. of gas generated, lb.		0.0558
91	Weight of water decomposed per lb. of dry coal fired, lb.		0.281
92	Weight of water decomposed per lb. of combustible consumed, lb.		0.355
93	Weight of water decomposed per lb. of air supplied		0.0702
94	Weight of water supplied per lb. of dry coal fired, lb.		0.440
95	Weight of water supplied per lb. of combustible consumed, lb.		0.556
96	Weight of water supplied per lb. of air used, lb.		0.1097
97	Total weight of scrubber water, lb.		22200.
98	Total weight of water absorbed by dryer		15.

[1] Steam fed to vaporizer.

WATER PER HOUR

99	Water evaporated per hr. in vaporizer, lb.	
100	Water evaporated per hr. per sq. ft. of water heating surface in vaporizer, lb.	
101	Weight of water decomposed per hr., lb.	18.2
102	Total weight of water fed to producer per hr., lb.	28.5
103	Weight of scrubber water used per hr. lb.	1850

QUANTITY OF AIR

104	Relative humidity of air, per cent	73.
105	Per cent of moisture contained in air, per cent by weight of dry air	1.66
106	Total weight of dry air by analysis, lb.	3112
107	Total weight of dry air by orifice, lb.	
108	Total weight of dry air as used in calculations, lb.	3112
109	Weight of dry air per hr. from total used in calculations	259.2
110	Weight of dry air used per lb. of dry coal fired, lb.	4.01
111	Weight of dry air used per lb. of combustible consumed, lb.	5.07
112	Weight of dry air used per lb. of dry gas generated, lb.	0.796

GAS

113	Volume of gas passing through meter at dryer, cu. ft.	31.06
114	Volume of standard gas passing through meter at dryer, cu. ft.	28.0
115	Total weight of gas passing through dryer meter, lb.	1.9
116	Percentage of moisture in gas leaving producer, from dryer, per cent dry gas	1.74
117	Percentage of moisture in gas leaving producer, from water fed to producer, per cent dry gas	3.15
118	Percentage soot and tar in gas leaving producer, per cent	
119	Calorific value per cu. ft. of standard gas from analysis B.t.u. (high value)	138.1
120	Calorific value per cu. ft. of standard gas from calorimeter, B.t.u. (high value)	137.3
121	Specific weight of standard gas, lb. per cu. ft.	0.0680
122	Specific heat of dry gas leaving producer	0.3281
123	Carbon ratio C/H	14.07
124	Total volume of gas from meters, cu. ft.	60630
125	Total volume of standard gas, from meters, cu. ft.	57500.
126	Total volume of standard gas, from analysis, cu. ft.	56200
127	Total volume as used in calculations, cu. ft.	57500
128	Volume of standard gas per hr. from total used in calculations.	4795
129	Volume of standard gas per lb. of dry coal from total used in calculations, cu. ft.	74.1
130	Volume of standard gas per lb. of combustible from total used in calculations, cu. ft.	93.7
131	Total weight of standard gas from total used in calculations, lb.	3912

132	Weight of standard gas per hr., lb.	326
133	Weight of standard gas per lb. of dry coal, lb.	5.03
134	Weight of standard gas per lb. of combustible, lb.	6.37

GAS ANALYSIS BY VOLUME

135	Carbon dioxide, CO_2	4.20
136	Carbon monoxide, CO	27.01
137	Oxygen, O_2	0.23
138	Hydrogen, H_2	10.40
139	Marsh gas, CH_4	1.77
140	Olefiant gas, C_2H_4	
141	Sulphur dioxide, SO_2	
142	Hydrogen sulphide, H_2S	
143	Nitrogen, N_2 by difference	56.40

GAS ANALYSIS BY WEIGHT

144	Carbon dioxide, CO_2	7.16
145	Carbon monoxide, CO	29.25
146	Oxygen, O_2	0.29
147	Hydrogen, H_2	0.81
148	Marsh gas, CH_4	1.12
149	Olefiant gas, C_2H_4	
150	Sulphur dioxide, SO_2	
151	Hydrogen sulphide, H_2S	
152	Nitrogen, N_2, by difference	61.37

EFFICIENCY

153	Grate efficiency, per cent	95.3
154	Hot gas efficiency, based on high heating value, per cent	90.9
155	Cold gas efficiency, based on high heating value, per cent	78.3

EFFICIENCY BASED ON COMBUSTIBLE

155*a*	Hot gas efficiency, based on high heating value, per cent	95.4
155*b*	Cold gas efficiency, based on high heating value, per cent	82.2

COST OF GASIFICATION

156	Cost of fuel per ton delivered in producer room	
157	Cost per 1000 cu. ft. of standard gas, cents	
158	Cu. ft. scrubber water per 1000 cu. ft. standard gas	6.18

POKING

159	Method of poking .... From top, slicing from bottom	
160	Frequency of poking .... Three times during test	

FIRING

161	Method of firing .... Hand	
162	Average intervals between firings .... Twice during run	
163	Average amount of fuel charged each time	250

HEAT BALANCE

Debit	B.t.u.
a Total heat supplied per lb. dry coal	13040
b Total heat supplied by air per lb. dry coal	19
c Total heat supplied by moisture in air per lb dry coal	
d Total heat supplied by moisture in coal	
e Total heat supplied as sensible heat in coal	
f Total[3] heat supplied in vaporizer water	385
Total	13444

Credit	B.t.u.	Per Cent
a Heat contained as sensible heat in dry gas	1725	12.8
b Heat contained in moisture	262	2.0
c Heat contained in dry gas (heat of combustion)	10240	76.2
d Heat in unburned carbon	618	4.6
e Heat contained as sensible heat in ash and refuse		
f Heat lost in overflow from vaporizer		
g Radiation and conduction, by difference	599	4.4
Total	13444	100.0

FORM 3 GUIDE SHEET CONTAINING ALL FORMULAE AND THEIR DERIVATION

The item numbers refer to the items of Form 2, and are arranged in the order of computation.

Item 4. "Depth of fuel bed" is to a certain extent arbitrary. In order that the term may have a fixed and definite meaning we will define it as the distance between the upper edge of the ash zone and that section of the fuel bed from which the gases separate and leave the fuel. The upper edge of the ash zone can ordinarily be readily determined by inspection.

Item 16. This reading is the average of the barometer readings for the test and is not corrected.

Item 17. Item 16 corrected. The following formula may be used:

Let H = corrected barometer reading.

t = temperature, deg. fahr.

h = barometer reading corresponding to temperature t.

Then $H = h\,(1.00254 - 0.000079t)$

Item 17. = Item 16 (1.00254 − 0.000079 × Item 29)

Item 18. = Observed.

Item 19. = Observed.

Item 20. = Item 17 − Item 19 × 0.0735

Item 21. = Observed.

Item 22. = Item 17 − Item 21 × 0.0735

[3] Supplied in steam.

Item 23. = Observed.
Item 24. = Item 17 + Item 23 $\times$ 0.0735
Item 25. = Taken from steam tables using temperature in Item 44, 1 lb. per sq. in. = 2.04 in. Hg.
Item 26 = Item 24 − Item 25
Item 27. = Observed.
Item 28. = Item 17 − Item 27 $\times$ 0.0735
Items 29 to 48. The observed temperatures should be corrected from the calibration curves before being placed in Form 2. The absolute temperature = the observed temperature + 460 deg.
Item 39. This item is observed in deg. cent. and should be transferred into deg. fahr.

$$\text{Deg. fahr.} = \frac{9}{5}\,\text{deg. cent.} + 32$$

Each observation must be transferred.
Item 50. Taken from Item 67.

$$\textit{Item}\ 51.\quad \text{Item } 49\left(1 - \frac{\text{Item } 50}{100}\right)$$

Item 52. Taken from ash sheet, correction being made for any moisture taken up in the ashpit.
Item 54. In these tests the total weight of combustible consumed will be taken as the total weight of dry coal fired.
The weight of ash is computed from the analysis.
The weight of nitrogen = $\frac{9}{8}$ $\times$ the weight of oxygen.
The weight of carbon contained in the ash and refuse equals

$$\text{Item } 51 - \frac{\text{Item } 51 \times \text{Item } 66}{100} - \frac{\text{Item } 51 \times \text{Item } 64}{100} - \frac{\frac{9}{8}\,\text{Item } 51 \times \text{Item } 63}{100} - \frac{\text{Item } 52 \times \text{Item } 68}{100}$$

Therefore,

$$\text{Item } 54 = \text{Item } 51\left[1 - \frac{\text{Item } 66 + \text{Item } 64 + \frac{9}{8}\,\text{Item } 63}{100}\right] - \frac{\text{Item } 52 \times \text{Item } 68}{100}$$

$$\textit{Item}\ 55. = \frac{\text{Item } 52 \times 100}{\text{Item } 51}$$

Items 56 to 69. From chemist.
Items 69, 1,2, 3, *and* 4. The ultimate analysis of the ash will be made only in special cases to obtain data on the formation of clinker.

$$\textit{Item}\ 70. = \frac{\text{Item } 51}{\text{hours}}$$

$$\textit{Item}\ 71. = \frac{\text{Item } 54}{\text{hours}}$$

Item 72. $= \dfrac{\text{Item 70}}{\text{Item 2}}$

Item 73. $= \dfrac{\text{Item 71}}{\text{Item 2}}$

Item 74. $= \dfrac{\text{Item 70.}}{\text{Item 5}}$

Item 75. $= \dfrac{\text{Item 71.}}{\text{Item 5}}$

Item 76. "The rate of descent of dry coal through the fuel bed," or "The dry coal per cu. ft. of fuel bed per hour," which is the same, offers a means of comparing the rate of gasification in different producers that seems to be better adapted for the purpose than the expressions taken from boiler pratice, viz: "coal per sq. ft. of grate area," or "coal per sq. ft. of fuel bed," the latter having been used in producer practice.

Item 76. $= \dfrac{\text{Item 74}}{\text{Item 4}}$

Item 77. $= \dfrac{\text{Item 75}}{\text{Item 4}}$

Item 78. Taken from chemist's report.

Item 79. $= \dfrac{\text{Item 78} \times \text{Item 51} - \text{Item 52} \times \text{Item 68} \times 145.40}{\text{Item 54}}$

Item 80. $= \left\{\text{Item 61} \times 145.40 + \text{Item 65} \times 40.00 + [\text{Item 62} - \tfrac{1}{8} \text{ of Item 63}] \times 620.00\right\}$

Item 81. $= \dfrac{\text{Item 80} \times \text{Item 51} - \text{Item 52} \times \text{Item 68} \times 145.40}{\text{Item 54}}$

Item 113. Total volume of gas passing through meter at dryer. Observed.

Item 114. Total volume of standard gas passing through meter at dryer. Neglecting the effect of moisture.

Let p_1 = absolute pressure in inches Hg. at dryer meter.
t_1 = absolute temperature, deg. fahr. at dryer meter.
v_1 = total volume of gas passing through meter.
P, V, and T, be the condition of standard gas.
P = 30 in. Hg.
$T = 460 + 62 = 522$
$V = ?$

Then

$$\frac{p_1v_1}{t_1} = \frac{PV}{T}$$

$$\text{or } V = \frac{p_1v_1T}{Pt_1} = \frac{p_1v_1 \times 522}{30t_1} = \frac{17.4\, p_1v_1}{t_1}$$

from which the value of Item 114 follows.

Item 114. $= 17.4 \dfrac{\text{Item 28} \times \text{Item 113}}{\text{Item 47}}$

Item 118. Not considered in these tests.

Item 119. One cubic foot of standard gas, that is, gas at a temperature of 62 deg. fahr. or 522 deg. absolute and a pressure of 30 in. Hg., gives up on combustion, when the products of combustion are brought back to this temperature and the moisture is condensed, the following heat quantities:

H_2 = 328 B.t.u. per cu. ft. of standard gas.
C_2H_4 = 1480 B.t.u. per cu. ft. of standard gas.
CO = 319 B.t.u. per cu. ft. of standard gas.
CH_4 = 1010 B.t.u. per cu. ft. of standard gas.

Item 120. This quantity is the average of all the calorimeter determinations. Each separate determination by the calorimeter must be computed and the heating value obtained. The following formula may be used. The calorimeter readings are taken in centigrade units with the exception of the meter readings and pressure.

Let t_2 = temperature of entering water, deg. cent.
t_1 = temperature leaving water, deg. cent.
r = rise in temperature of water, deg. cent.
W = weight of water used during the intervals = 8 litres for all tests.
G_1 = cu. ft. of gas used from meter.
t_g = temperature of entering gas, deg. cent.
p_g = pressure entering gas inches Hg. absolute, corrected for vapor pressure of water (see Item 25).
H = heating value per cu. ft. of standard gas (62 deg. fahr. or 16.7 deg. cent. and 30 in. Hg.)
t_s = temperature of standard gas = 62 deg. fahr. or 16.7 deg. cent.
p_s = pressure of standard gas = 30 in. Hg.
G_s = cu. ft. of standard gas.

$$\frac{G_1\,p_g}{t_g} = \frac{G_s\,p_s}{t_s}$$

$$G_s = \frac{G_1 \times p_g \times t_s}{t_g \times p_s}$$

Where t_g and t_s are in absolute deg. cent., $t_1 - t_2 = r$
Total heat per cu. ft. standard gas in B.t.u. = H.
Total heat absorbed by water = W × r

$$H = \frac{W \times r \times 3.968}{G_s} = \frac{W \times r \times 3.968}{\dfrac{G_1 \times p_g \times t_s}{t_g \times p_s}}$$

$$= \frac{8 \times r \times 3.968 \times t_g \times 30}{G_1 \times p_g \times (16.7 + 273)} =$$

$$\frac{t_g \times r \times 3.29}{G_1 \times p_g}$$

where 3.968 is the conversion factor.

In this formula it is assumed that the exhaust products are brought back to 62 deg. fahr. This is not strictly true but the error introduced is negligible, when the error in the use of the apparatus is considered. There is another error due to the exhaust products carrying out more or less vapor of water than was brought in by the entering gas and air.

This error will also be small and may either be positive or negative depending on conditions. The entering gas will in most cases come from direct contact with water and will therefore be saturated. The air ordinarily will not be saturated. On combustion, moisture will be formed by the union of the oxygen and hydrogen, there will be a contraction in volume of the gases due to the combustion, and also a contraction or expansion due to a change in temperature after combustion. In whichever direction the change in the weight of moisture in the out-going gas from that brought in by the entering gas may occur, this change may be considered very small; for the contraction on combustion will be comparatively small, and this contraction will partly offset the unsaturated condition of the air used for combustion. Also the change in temperature of the out-going gas from that of the entering gas will be small.

The heating values as given in Items 119 and 120 are the *high values*.

The values obtained from the analysis will be more accurate and will be used in all computations.

Item 121. The specific weights of the following gases at 62 deg. and 30 in. Hg. are

$CO_2 = 0.11610$	$CH_4 = 0.04278$
$CO = 0.07362$	$C_2H_4 = 0.07370$
$O_2 = 0.08418$	$SO_2 = 0.16380$
$H_2 = 0.00530$	$H_2S = 0.08682$

$$N_2 = 0.07400$$

Item 121. = [Item 135 × 0.1161 + Item 136 × 0.07362 + Item 137 × 0.08418 + Item 138 × 0.00530 + Item 139 × 0.04278 + Item 140 × 0.0737 + Item 141 × 0.1638 + Item 142 × 0.08682 + Item 143 × 0.0740] $\frac{1}{100}$

Items 144 to 152. Calculation of the gas analysis by weight from the analysis by volume. Assume that we have one cubic foot of gas at 62 deg. fahr. and 30 in. Hg. of the following composition:

Volumetric Analysis	Specific Weights	Analysis by Weight Per Cent
$CO_4 = a$ per cent	$0.1161 = W_a$	$a = \frac{W_a \times a}{W}$
$CO = b$	$0.07362 = W_b$	$b = \frac{W_b \times b}{W}$
$O_2 = c$	$0.08418 = W_c$	$c = \frac{W_c \times c}{W}$
$H_2 = d$	$0.00530 = W_d$	$d = \frac{W_d \times d}{W}$

Volumeric Analysis	Specific Weights	Analysis by Weight Per Cent
$CH_4 = e$	$0.04278 = W_e$	$e = \frac{W_e \times e}{W}$
$C_2H_4 = f$	$0.07370 = W_f$	$f = \frac{W_f \times f}{W}$
$SO_2 = g$	$0.16380 = W_g$	$g = \frac{W_g \times g}{W}$
$H_2S = h$	$0.08682 = W_h$	$h = \frac{W_h \times h}{W}$
$N_4 = i$	$0.07400 = W_i$	$i = \frac{W_i \times i}{W}$

Where $W = [a \times W_a + b \times W_b + c \times W_c + e \times W_e \ldots + i \times W_z] \frac{1}{100}$ = Item 121.

Item 122. The specific heats of the gases vary according to the pressure and temperature. As the pressure used throughout the experiments is atmospheric we have only to consider the variation with the temperature. The following formulae taken from Zeuner, vol. I, page 147, give the specific heat for constant volume C_v.

$$^{1}CO_2,\ mC_v = 6.50 + 0.00774t \ldots\ldots (1)$$
$$H_2O,\ mC_v = 5.78 + 0.00572t \ldots\ldots (2)$$
$$O_2\, H_2\, N_2, CO,\ mC_v = 4.76 + 0.00244t \ldots\ldots (3)$$
$$mC_p - mC_v = 1.9934 \ldots\ldots (4)$$

For the specific heat of marsh gas CH_4, our other constituent, we will use the value $C_p = 0.6$. This is approximate, but as the quantity of CH_4 is small the resultant error is consequently small.

In the above formula, m is the molecular weight of the gas, t the temperature in deg. cent, and C_v the mean specific heat between zero and t deg. cent. C_p is determined from formula (4). From the above formulæ, the analysis by weight as determined below and the temperature of the gases leaving the producer, the specific heat of each constituent in a unit weight of the gas may be determined. The specific heat of the gas will be the sum of the specific heats of the constituents.

Substituting the value of mC_v from formula (4), and the value of m, and changing to deg. fahr. we have from the above formulae:

$$\text{For } CO_2,\ C_p = 0.19 + .0000977t \ldots\ldots a$$
$$H_2O,\ C_p = 0.426 + .000176t \ldots\ldots b$$
$$H_2,\ C_p = 3.355 + .000678t \ldots\ldots c$$
$$CO,\ C_p = 0.24 + .0000484t \ldots\ldots d$$
$$N_2,\ C_p = 0.24 + .0000484t \ldots\ldots e$$
$$CH_4,\ C_p = 0.6 \ldots\ldots f$$
$$O_2,\ C_p = 0.21 + .0000424t \ldots\ldots g$$

[1]Mallard and Le Chatellier's Formulae.

Let a, b, c, d, e, and f, represent the mean C_p for the above gases between 32 deg. and t deg. fahr. Then the C_p of the producer gas = the sum of the products of the constituents of the gas by weight × the specific heat of the constituent.

That is,

$$\text{Item } 122 = [a \times \text{Item } 144 + c \times \text{Item } 147 + d \times \text{Item } 145 + e \times \text{Item } 152 + f \times \text{Item } 148 + g \times \text{Item } 146]\ \frac{1}{100}$$

Item 123

1	2	3	4
$CO_2 = O_2 + C$	$CO = C + O$	$CH_4 = C + 2H_2$	$C_2H_4 = 2C + 2H_2$
$44 = 32 + 12$	$28 = 12 + 16$	$16 = 12 + 4$	$28 = 24 + 4$

The total weight of carbon appearing in a unit weight of gas from the above =

per cent by weight $CO_2 \times \frac{3}{1100}$ + per cent by weight $CO \times \frac{3}{700}$ + per cent by weight $CH_4 \times \frac{3}{400}$ + per cent by weight $C_2H_4 \times \frac{6}{700}$

The total weight of H_2 appearing in a unit weight of gas = per cent by weight $\frac{H_2}{100}$ + per cent by weight $CH_4 \times \frac{1}{400}$ + per cent by weight $C_2H_4 \times \frac{1}{700}$

or Item 123 = [Item 144 × 0.273 + Item 145 × 0.429 + Item 148 × 0.75 + Item 149 × 0.858] ÷ [Item 147 + Item 148 × 0.25 + Item 149 × 0.143]

Item 124. Observed.

Item 125. Let G = total volume of gas as measured by the meters.
p = absolute pressure of this gas in inches Hg. as observed.
T = absolute temperature in deg. fahr.
t = observed temperature.

The volume of gas G as measured by the meter is saturated with water vapor at the temperature t.

Let p_1 = pressure of this vapor in inches as obtained from the steam table.

Then as the pressure p is the total pressure of the mixture, the actual or partial pressure of the dry gas is $p - p_1 = p_2$.

Let p_s, G_s, and T_s. be the condition of standard gas. Then

$$\frac{G_s \times p_s}{T_s} = \frac{G \times p_2}{T} \text{ or } G_s = \frac{G \times p_2 \times T_s}{T \times p_s} = \frac{G \times p_2 \times 522}{T \times 30} = \frac{G \times p_2}{T} \times 17.4$$

Therefore Item 125 equals

$$\frac{\text{Item } 124 \times \text{Item } 26 \times 17.4}{\text{Item } 45}$$

Item 126. Calculation of the volume of the gas from the analysis of the gas and the analysis of the coal. Evidently the total weight of the carbon appearing in the gas should be equal to the total weight of carbon in the coal minus the weight that is lost through the grate and the weight lost in soot and tar. This latter is small for the hard-coal producer and will be neglected.

Let P = Per cent carbon by weight in dry coal.
W = total weight of dry coal.
W_1 = total weight of ash and refuse.
P_1 = Per cent by weight of carbon in the ash and refuse.
W_2 = total weight of carbon that should appear in the gas, or the weight of carbon utilized in the producer.

$$W_2 = \frac{PW - P_1W_1}{100}$$

This carbon is contained in the CO_2, CO, CH_4, and C_2H_4.

The proportion by weight of C in CO_2 is 3/11, of C and CO is 3/7, of C in CH_4 is 3/4 and of C in C_2H_4 is 6/7.

Therefore the total weight of C contained in a unit weight of gas will be

$$W_3 = \frac{3/11\, A + 3/4\, E + 3/7\, F + 6/7\, G}{100}$$

Where A, E, F, and G are the per cent by weight of CO_2, CH_4, CO, and C_2H_4 from the gas analysis.

The per cent of this carbon contained in the gas as CO_2 is $\dfrac{3/11\ \text{A}}{W_3}$

The actual weight of this carbon will be $\dfrac{3/11\ \text{A}}{W_3 \times 100} \times W_2$. Since W_2 is the total weight of carbon utilized, from the fuel.

One pound of carbon on burning produces $3\frac{2}{3}$ lb. of CO_2.

$$W_2 \times \frac{3/11\ \text{A}}{W_3 \times 100} \times 3\tfrac{2}{3} = \text{total weight of } CO_2 \text{ in the gas.}$$

Let W_8 = the specific weight of CO_2 at 62 deg. and 30 in. Hg. See Item 121. The standard volume V_8 of CO_2 will therefore be,

$$\frac{AW_2}{100 \times W_3 \times W_8} = V_8$$

Let this volume equal a per cent (from the volumetric gas analysis) of the total volume of gas delivered by the producer. The total volume of standard gas from the gas analysis is therefore

$$\frac{100\ V_8}{a} = V'_8$$

$$V'_8 = \frac{A \times W_2}{a \times W_3 \times W_8}$$

Item 126 therefore equals

$$\frac{\text{Item 144} \times (\text{Item 51} \times \text{Item 61} - \text{Item 52} \times \text{Item 68})}{0.116 \times \text{Item 135} \times (0.273 \text{ Item 144} + 0.75 \text{ Item 148} + 0.429 \text{ Item 145} + 0.858 \text{ Item 149})}$$

Item 127. Item 126 should be used as a check on Item 125. The difference between the two values should not exceed 5 per cent. Item 125 should be used in all computations.

Item 128 $= \dfrac{\text{Item 127}}{\text{hours}}$

Item 129 $= \dfrac{\text{Item 127}}{\text{Item 51}}$

Item 130 $= \dfrac{\text{Item 127}}{\text{Item 54}}$

Item 131 $=$ Item 127 $\times$ Item 121

Item 132 $= \dfrac{\text{Item 131}}{\text{hours}}$

Item 133 $= \dfrac{\text{Item 131}}{\text{Item 51}}$

Item 134 $= \dfrac{\text{Item 131}}{\text{Item 54}}$

Items 135 to 143 From chemist.

Item 104. The relative humidity, or per cent saturation is observed by means of a hair hygrometer. This may also be obtained from a wet and dry bulb thermometer, and a set of psychrometric tables.

Item 105. See Kent, page 484 for weights of air and moisture.

Let p = per cent saturation, or relative humidity, Item 104.

n = weight of moisture contained in one cu. ft. of saturated air at the observed temperature, Item 29.

$\dfrac{pn}{100}$ = weight of moisture in 1 cu. ft. of air as used.

If m = weight of 1 cu. ft. dry air at the observed temperature, then

$$\text{Item 105} = \frac{pn}{100m} \times 100 = \frac{pn}{m} = \text{Item 104} \times \frac{n}{m}$$

This formula is in error due to neglecting the vapor pressure of water; this is, however, negligible in the present case.

Item 82. Observed.

Item 83. Observed.

Item 84. = Item 82 − Item 83.

Item 86. The weight of water decomposed in the producer is evidently 9 times the weight of hydrogen formed, since 1 lb. of water on decomposition yields 1 lb. of hydrogen and 8 lb. oxygen. The total weight of hydrogen formed is equal to the total weight of free hydrogen appearing in the gas, plus the total weight of hydrogen appearing in the CH_4 in the gas, minus

the total weight of hydrogen that is not in combination with oxygen in the coal.

Item 86 therefore, equals

$$9\ \frac{\text{Item 131 (Item 147 + 0.25 Item 148)} - \text{Item 51 (Item } 62 - \frac{1}{8}\text{ Item 63)}}{100}$$

Item 87. Owing to the difficulty in obtaining the weight of moisture in the gases leaving the producer with a proper degree of accuracy by the use of a dryer, it will ordinarily be better to use Item 86 for this item.

Item 106. Obtained from the gas analysis by weight, Items 144 to 152 inclusive.

Let A = per cent CO_2
B = per cent O_2.
C = N_2

Let D = per cent H_2
E = per cent CH_4
F = per cent CO

1	2	3
$C = O_2 = CO_2$	$C + O = CO$	$H_2 + O = H_2O$
$12 + 32 = 44$	$12 + 16 = 28$	$2 + 16 = 18$
$\frac{3}{11} + \frac{8}{11} = 1$	$\frac{3}{7} + \frac{4}{7} = 1$	$\frac{1}{9} + \frac{8}{9} = 1$

Fom equation (1), one lb. of CO_2 requires 8/11 lb. of O for its formation
From (2) one lb. CO requires 4/7 lb. of O for its formation.
The total amount of O appearing in 1 lb. of the gas is therefore

$$\left(\frac{8}{11}A + \frac{4}{7}F + B\right) \times \frac{1}{100}$$

This O comes from that contained in the air, that contained in the coal, and from the water decomposed. The oxygen contained in the coal, however, is supposed to be united with hydrogen, and is therefore contained in moisture, which has been allowed for in the water decomposed.

Let W = total weight of gas.

Then the total weight of O used is

$$\frac{W}{100}\left(\frac{8}{11}A + \frac{4}{7}F + B\right)$$

Let W_2 = weight of water decomposed. From (3), 1 lb. of water decomposed liberates 8/9 lb. of O.
Weight of O supplied by decomposition of water = 8/9 W_2
Let W_3 = total weight of O supplied by the air.
From the above equation we have,

$$\left(\frac{8}{11}A + \frac{4}{7}F + B\right)\frac{W}{100} = \frac{8}{9}W_2 + W_3,$$

$$\text{or } W_3 = \frac{W}{100}\left(\frac{8}{11}A + \frac{4}{7}F + B\right) - \frac{8}{9}W_2 \quad \ldots\ldots\ldots\ldots (4)$$

The weight of air used is therefore $\frac{W_3}{0.23,}$ since the proportion by weight of O in air is 23, or

$$\frac{W_3}{0.23} = W_4 = \frac{1}{0.23}\left[\frac{W}{100}\left(\frac{8}{11}A + \frac{4}{7}F + B\right) - \frac{8}{9}W_2\right] \ldots\ldots (5)$$

$$\text{Therefore Item 106} = \left[\frac{\text{Item 131}}{100}\left(\frac{8}{11}\text{ Item 144} + \frac{4}{7}\text{ Item 145} + \text{Item 146}\right) - \frac{8}{9} \times \text{Item 87}\right]\frac{1}{0.23} \ldots\ldots (6)$$

The above computation may be made from the weight of nitrogen appearing in the gas. The nitrogen comes from the air used and from the nitrogen introduced with the fuel.

Let C per cent per lb = weight of N_2 from analysis

Let W as before = total weight of gas.

Then $\frac{C\,W}{100}$ = total weight of N_2 in the gas.

The weight of N_2 supplied by fuel will be $\frac{W_1\,H_1}{100}$, where W_1 equals the total weight of dry coal and H_1 is the per cent by weight of N_2 contained in the coal. We have therefore,

$$\frac{CW}{100} = \frac{W_1H_1}{100} + W_4$$

where W_4 = total weight of N_2 in the air.

The weight of air supplied is therefore

$$\frac{W_4}{0.77} = \left(\frac{CW}{100} - \frac{W_1H_1}{100}\right)\frac{1}{0.77} = W_5 = \left(\frac{CW - W_1H_1}{77}\right)$$

$$\text{or Item 106} = (\text{Item 131} \times \text{Item 152} - \text{Item 51} \times \text{Item 64})\frac{1}{77} \ldots\ldots (7)$$

The weight of air derived by formula (6) will be liable to error, due principally to the error in the determination of the total quantity of water decomposed, which may be large, and also to the neglecting of the SO_2 formed.

The weight determined by formula (7) will be in error due principally to the taking of the weight of N_2 from the analysis by difference.

The results obtained from formulae (6) and (7) should check within 5 per cent.

The results obtained by (7) are believed to be more accurate and will be used in all computations.

Item 107 This may be obtained direct from the calibration curve of the orifice. It should be compared with the two values obtained above.

Item 108. This will ordinarily be taken from Item 106.

$$\textit{Item } 109 = \frac{\text{Item } 108}{\text{Hours}}$$

$$\textit{Item } 110 = \frac{\text{Item } 108}{\text{Item } 51}$$

$$\textit{Item } 111 = \frac{\text{Item } 108}{\text{Item } 54}$$

$$\textit{Item } 112 = \frac{\text{Item } 108}{\text{Item } 131}$$

$$\textit{Item } 85 = \text{Item } 84 + \text{Item } 85b + \text{Item } 85c.$$

$$\textit{Item } 85b = \frac{\text{Item } 108 \times \text{Item } 105}{100}$$

$$\textit{Item } 85c = \frac{\text{Item } 49 \times \text{Item } 50}{100}$$

$$\textit{Item } 88 = \text{Item } 85 - \text{Item } 87$$

$$\textit{Item } 89 = \frac{\text{Item } 87}{\text{Item } 85}$$

$$\textit{Item } 90 = \frac{\text{Item } 87}{\text{Item } 131}$$

$$\textit{Item } 91 = \frac{\text{Item } 87}{\text{Item } 51}$$

$$\textit{Item } 92 = \frac{\text{Item } 87}{\text{Item } 54}$$

$$\textit{Item } 93 = \frac{\text{Item } 87}{\text{Item } 108}$$

$$\textit{Item } 94 = \frac{\text{Item } 85}{\text{Item } 51}$$

$$\textit{Item } 95 = \frac{\text{Item } 85}{\text{Item } 54}$$

$$\textit{Item } 96 = \frac{\text{Item } 85}{\text{Item } 108}$$

$$\textit{Item } 97 = \text{Observed}$$

$$\textit{Item } 98 = \text{Observed}$$

$$\textit{Item } 99 = \frac{\text{Item } 84}{\text{Hours}}$$

$$\textit{Item } 100 = \frac{\text{Item } 99}{\text{Item } 11}$$

$$\textit{Item } 101 = \frac{\text{Item } 87}{\text{Hours}}$$

$$\textit{Item } 102 = \frac{\text{Item } 85}{\text{Hours}}$$

$$\textit{Item } 103 = \frac{\text{Item } 97}{\text{Hours}}$$

$$\textit{Item } 115 = \text{Item } 114 \times \text{Item } 121$$

$$\textit{Item } 116 = \frac{\text{Item } 98 \times 0.2205}{\text{Item } 115}$$

$$\textit{Item } 117 = \frac{100 \text{ Item } 88}{\text{Item } 131}$$

Item 153 The grate efficiency is 100 times the ratio of the total B.t.u. in the fuel minus the B.t.u. in the fuel lost through the grate; to the total B.t.u. contained in the fuel. Therefore

$$\text{Item } 153 = \frac{\text{Item } 51 \times \text{Item } 78 \times 100 - \text{Item } 52 \times \text{Item } 68 \times 14540}{\text{Item } 51 \times \text{Item } 78}$$

Item 154. The hot gas efficiency is 100 times the ratio of the total heat of combustion of the gas, plus the sensible heat of the dry gas, plus the total heat contained in the moisture, minus the heat given to the producer by the entering air, by the coal as sensible heat and by the moisture or steam in the air, or supplied from any outside source; to the heat of combustion of the dry coal. Therefore, Item 154 = $\{$Item 119 × Item 127 + Item 122 × Item 131 (Item 39 − 62 deg. + Item 88 [1116 + 0.6 (Item 39−212)] − Heat from external source$\}$ × 100 ÷ Item 51 × Item 78.

The heat given to the producer by the air, moisture, coal, etc., may be neglected if the room temperature is within 20 deg. of the standard temperature 62 deg. This will ordinarily be the case. If steam is supplied to the producer by a steam nozzle taking steam from some outside source, the heat in this steam must be subtracted from the numerator of the above formula.

Item 155 The cold gas efficiency is 100 times the ratio between the total heat of combustion of the gases, to the total heat of combustion of the dry coal. That is,

$$\text{Item } 155 = \frac{\text{Item } 119 \times \text{Item } 127}{\text{Item } 51 \times \text{Item } 78} \, 100$$

$$\textit{Item } 157 = \frac{\text{Item } 156 \times \text{Item } 49}{0.02 \times \text{Item } 127}$$

$$\textit{Item } 158 = \frac{\text{Item } 97 \times 1000}{62.5 \times \text{Item } 127} = \frac{\text{Item } 97}{0.0625 \times \text{Item } 12}$$

HEAT BALANCE

DEBIT

Item 1. Obtained from Item 78.

Items 2, 3, 4, 5, 6, Using as a standard the temperature of 62 deg. fahr., the heat given to the producer by the items 2 to 6 inclusive is in most cases negligible. The error at a temperature of 100 deg. fahr. is less than 1 per cent for a producer of the contained vaporizer type. However, the formulae will be given for computation of these items.

Item 2 = Item 110 × 0.24 (Item 30 − 62°F)

Item 3 $= \dfrac{\text{Item 85b} \times (H - 1070)}{\text{Item 51}}$ where H = the total heat in 1 lb. saturated steam at the temperature of the fire room.

Item 4 $= \dfrac{\text{Item 49} \times \text{Item 50}}{100 \times \text{Item 51}}$ (Item 30 − 62 deg. fahr.)

Item 5 = 0.24 × (Item 30 − 62 deg. fahr.)

Item 6 $= \dfrac{\text{Item 82 (Item 33} - \text{62 deg. fahr.)}}{\text{Item 51}}$

CREDIT.

Item 1 = Item 122 × Item 133 × (Item 39 − 62 deg. fahr.)

Item 2 $= \dfrac{\text{Item 117} \times \text{Item 133}}{100}$ [(Item 39 − 212 deg. fahr.) × 0.6 + 1116]

Item 3 = Item 119 × Item 129

Item 4 $= \dfrac{\text{Item 52} \times \text{Item 68}}{\text{Item 51}} \times 145.40$

Item 5 This is very small and may be neglected.

Item 6 $= \dfrac{\text{Item 83}}{\text{Item 51}}$ (Item 34 − 62 deg. fahr.)

Item 7 = Sum of Items on debit side − (Item 1 + Item 2 + Item 3 + Item 4 + Items 5 and 6.)

LINE SHAFT EFFICIENCY, MECHANICAL AND ECONOMIC

By Henry Hess, Philadelphia

Member of the Society

The efficiency to be treated in this paper is that of the line shaft considered as an element for the transmission of power.

2 The complete power transmission system is made up of the shaft and pulleys; the belts, ropes or other equivalents; and the journals supporting all of these.

3 The difference between the power delivered to the system and that delivered by it is consumed in the work of bending and slipping the belts and overcoming the friction of the journals. There may be another loss due to the bending of badly aligned shafting; but as misalignment should not occur and as the remedy is obvious, it will not be considered further.

4 The power lost in the bending of the belts and in their slipping or creeping is but a small fraction of the total loss, and one, moreover, that cannot be materially lessened; assuming, of course, that belts are kept properly pliable and not allowed to dry out, become caked with dust or stiffened with adhesive dopes, all causes of loss of belt efficiency that no good shopman will allow to exist.

5 There remains the journal friction. In the average plant this accounts for nine-tenths or even more of the entire line shaft losses. Included in the journal friction are the losses at the loose pulley bearings and the countershafts.

6 The coefficient of friction of plain babbitted or of cast iron bearings ranges all the way from ½ of 1 per cent to 8 per cent. This range covers all of the many methods of lubrication in general use. The better value is rarely realized outside of the laboratory; the poorer value is by no means as rarely found as it should be. A showing of 3 per cent friction coefficient is one that the manager may well pride

himself on; while a coefficient of 5 per cent is much more general, but need not, as conditions are, be taken as reflecting adversely on attention to details.

7 The remedy obviously lies in the substitution of ball bearings for plain bearings. In other fields than line shafting this remedy finds considerable employment; in some the plain bearing has indeed been superseded almost entirely. This is particularly the case where the power efficiency is of great importance, as for instance, in the automobile.

8 While some shopmen still doubt the reliability of the ball bearing, those who have followed the development of modern machinery know that hundreds of thousands of ball bearings are carrying loads varying from a few ounces to many tons, day in and day out, at speeds ranging from a few turns per minute to 10,000 or more. They realize that it is not a question of reliability *per se*, but one of selection of sizes suitable for the loads to be dealt with.

9 For line shafting it is the economic question that is to the fore. The first cost of a ball bearing installation is greater than a plain bearing equipment. Will it pay for itself by the savings effected and if so at what rate? What return on the difference in investment can be realized? That there is a saving is generally known, but accurate figures are wanted by which a manager can justify his recommendation to those who control the purse strings and are responsible for dividends.

10 When only the idle running of the line shafts is considered answers to these questions can be easily obtained, now that electric motors are so generally applied directly to line shafts and it is so simple a matter to take readings of the power delivered to them. The difference in readings for the same shafts with plain and with ball bearings represents fairly accurately the saving for the idle run.

11 But line shafts are not put up to run idly; they drive machines and these machines are sometimes heavily loaded, sometimes lightly loaded and sometimes idle. While comparative current readings taken under these conditions may be fully satisfactory to those immediately concerned, this rather crude method cannot lay claim to that accuracy which is more and more being demanded by the engineering world.

PLAN OF TESTS

12 To supply definite information the author decided that a series of comparative tests should be made, involving no variables other than the bearings themselves. In order further to eliminate possible personal bias in favor of the ball bearings the author called on Messrs. Dodge and Day to make these tests, giving them carte blanche as to methods, with instructions confined to a demand for definite and reliable figures. This investigation is the first undertaken, so far as the author

FIG. 1 VIEW SHOWING LINE SHAFTING TESTED

knows, under conditions practically those of the work shop, the sole difference being the substitution of constant loads for the variables of ordinary working.

13 Besides the change in load due to the operation of the various machines driven from a line shaft, already referred to, there is the change in load due to variation in belt stress. A preliminary test quickly demonstrated that reliance could not be placed on the use of tension weighing clamps in putting on the belts. The tension was found to differ from that determined by the clamp scales. This error

could have been minimized by the use of the admirable methods and apparatus worked up by the engineers under our past-president, Fred. W. Taylor, and this plan was given serious consideration until it was found that the influence of varying humidity and temperature in the shop was such as greatly to change the tension of the belts even after they were in place.

14 The complete plan finally decided on and carried through was as follows: A line shaft of $2\frac{7}{16}$-in. diameter and 72-ft. length used

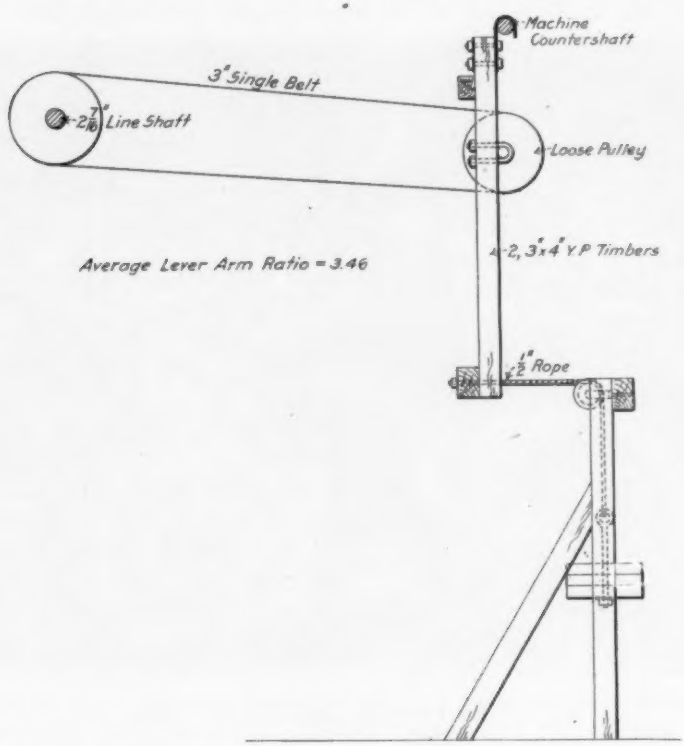


Fig. 2 Arrangement of Countershaft Frames Used During Comparative Tests of Ball and Ring-Oiling Bearings

to operate a series of heavy turret lathes was set aside for the test. This was alternately equipped with plain ring-oiling babbitted boxes and Hess-Bright ball bearings. In order to facilitate the exchange of bearings, the ball bearing boxes were placed on the shaft close to the hangers, making it necessary only to slip the plain bearings out of the hanger and slip the ball bearings in. Both types were held by the same supporting screws usual with modern hangers.

15 It is perhaps needless to mention that great care was exercised in seeing that the shaft was correctly aligned at the beginning of each test. It was supported by ten hangers, with an average

FIG. 3 ARRANGEMENT OF LINE SHAFT AND BELT DRIVES

spacing of 8 ft. See Fig. 1 to Fig. 3, the last of which shows the arrangement adopted to secure constant load.

16 The belts from the line shaft drive pulleys mounted on swings hung at their upper ends, loaded by ropes attached to their lower ends, which leads over guide pulleys to weights. The tension in the

belt is thus definitely determined by the weight and is independent of slight variatious of belt length from whatever cause. The load on the journals is therefore constant and definitely known. The only possible variable is in the friction of the loose pulleys on the swings These loose pulleys were ordinary tight pulleys picked up around the shop and arranged for oiling through the set screw holes and by the addition of channels. The friction was kept as near constant as possible by oiling at the beginning of every test. This answered fairly well except for two tests in which the rather small dimensions of the hubs gave rise to heating under the abnormally high belt tensions used.

17 Of such swings eight were employed. All were mounted on the same side of the shaft to avoid any uncertainty in load conditions that might have resulted from a possible balancing of pull from opposite sides.

18 Speeds and dimensions of shafts, pulleys, loose pulleys and loose pulley hubs, belts and belt material are marked in Fig. 2. The drive was supplied by a 10 h.p. motor from the floor. The tension of the main belt was kept constant by a weighted idler pulley bearing on its driving side.

19 Constancy of line shaft speed was assured by a rheostat inserted in the field of the 110-volt, direct-current, shunt-wound motor and the use of a Warner tachometer connected to the motor. The electrical measurements taken were the voltage across the motor terminals and ammeter readings of the armature and field currents. The electrical and mechanical losses of the motor were determined from electrical resistance and no load tests. These motor losses were deducted from the total electrical output, the balance being the power consumed by the line shaft system in journal friction, in loose-pulley hub friction, in belt bending and creep, in the motor belt tension idler and in windage. All instruments used were calibrated before and after the tests.

METHOD OF TESTING

20 The tests were divided into two duplicate series, the first, *A* with plain bearings on the line shaft; the second, *B*, with ball bearings on the line shaft. The sole variable was therefore that of the line shaft as affected by the change from plain to ball bearings.

21 In each series the effect of varying loads was determined by changing the belt tension by approximately equal increments from 20

to 90 lb. per inch width of single belt. This was supplemented by a test with all of the belts removed except the driving belt from the motor, leaving only the weight of shaft and pulleys for journal loads.

22 Each test lasted forty minutes of running time; a reading of the various instruments was taken every two minutes. That means a total of 10 hrs. 40 min. with a total of 960 recorded readings.

23 The loads on the line-shaft journals ranged from 126 to 662 lb. per journal; for the $2\frac{7}{16}$-in. by 10-in. ring-oiling babbitted bearings this gives loads ranging from 5.2 lb. to 27.3 lb. per sq. in. of projected area. For the ball bearings used, each of which had 12 balls of $\frac{9}{16}$-in. diameter, the load per ball was from 10.5 lb. to 55.2 lb.

24 It is pertinent to mention that these bearings have so far a record of nearly five years constant service under loads corresponding to about three-fourths of the maximum cited and show no evidence of wear. In that period they were lubricated but three times, once when put up, once for the test and once incidental to a shop moving.

RESULTS SHOWN BY THE TABLES

25 Details of the loading of the line shaft bearings and of the swing or countershaft idlers are given in Tables 1 and 2. Table 3 gives the averaged electrical readings for each test. Table 4 gives electrical readings with the power in kilowatts delivered to the belt and the percentage of saving due to the ball bearings. In the supplement to Table 4 is explained the derivations of the columns in Table 4 in reference to the deduction of motor losses from total input.

26 Table 4, last column, shows that the saving due to changing ten $2\frac{7}{16}$-in. plain ring-oiling babbitted bearings running at 214 r.p.m. to the ball bearings increases with increasing belt tensions from 14 per cent to 36 per cent. With the more usual belt tensions of good practice ranging from 44 lb. to 57 lb. per inch width of single belt (tests 3 and 4), the saving amounts to 36 per cent and 35 per cent.

DISCUSSION OF RESULTS

27 Tests 5 and 6 with belt tensions of 70 lb. and 83 lb. per inch width of single belt show lower savings of only 25 per cent. This falling off is due to the fact that the pressures were too high for the loose pulley hub-bearing surfaces, causing excessive heating and losses. This reduction of 25 per cent does not indicate a smaller actual saving due to the ball bearings, but simply that the increase was due to

TABLE 1 RESULTANT PRESSURES ON LINE SHAFT BEARINGS

Bearing No.	Line Shaft Dead Loads at Bearings Lbs.	Components of Belt Loads at Bearings (Lbs.)						Resultant Loads at Bearings (Lbs.)						Belt Number Corresponding to Bearing Loads
		Test Number						Test Number						
		1	2	3	4	5	6	1	2	3	4	5	6	
1	80.33	87.5	153.6	219.1	284.8	350.4	416.5	126	181.5	241.5	303.3	367.5	433	59
2	132.63	23.7 41.8	41.6 73.5	59.4 104.7	77.2 136.0	95.1 167.8	113.0 199.0	150.5	183.5	219	258	304.5	347.5	59 46
3	180.17	39.4 48.6	121.7 85.3	173.8 121.6	226.0 158.0	277.7 195.0	330.5 231.0	222.5	282.5	358	436	520	604	46 74
4	220.57	62.6 65.3	109.9 114.6	156.9 163.7	204.0 212.8	250.5 261.5	298.5 315.5	261	324.5	402	480	567	662	74 36
5	182.16	45.9 63.1	80.6 110.7	114.8 158.2	149.2 205.5	184.0 252.8	214.0 301.0	218	273.5	340	406	488	567	36 72
6	190.09	48.1 52.7	84.5 92.5	120.3 132.0	156.5 171.7	192.7 211.2	228.5 250.5	221.5	268	324.5	390	456	523	72 37
7	201.83	58.5 63.7	102.7 111.8	146.5 159.7	190.5 207.5	234.3 255.0	279.0 303.7	245	305.5	380.5	460	545	635.5	37 75
8	183.96	47.5 52.7	83.4 92.5	118.8 132.0	154.5 171.5	190.5 211.0	225.8 250.5	215	262	321	385	452	520	75 48
9	317.14	58.5 260	102.7 260	146.5 260	190.5 260	234.5 260	279.0 260	505	496	490	489	492	500	48 Motor Belt
10	138.71	60	60	60	60	60	60	185	185	185	185	185	185	Motor Belt
Total	1828.00	1210	1882	2548	3216	3884	4556	2350	2762	3262	3793	4377	4977	

TABLE 2 RESULTANT PRESSURES ON COUNTER SHAFT IDLERS

Pulley No.	Weight of Pulley and Half of Belt Lbs.	Belt Pulls on Idler Pulleys						Resultant Pressures on Idlers						R.P.M. of Idlers	Angle of Inclination of Belt From Horizontal
		Test Number						Test Number							
		1	2	3	4	5	6	1	2	3	4	5	6		
59	9.6	111.2	195.2	278.5	362.0	445.5	529.5	111.0	194.5	277.0	360.8	444.2	528.0	343	5° 38′
46	19.0	"	"	"	"	"	"	111.7	195.5	278.0	361.6	445.0	528.5	266	1° 16′
74	11.6	"	"	"	"	"	"	110.8	194.2	277.3	360.5	444.5	527.5	188	6° 41′
36	13.8	"	"	"	"	"	"	111.7	195.5	278.0	361.8	445.0	528.5	206	1° 55′
72	14.9	"	"	"	"	"	"	110.7	194.0	277.0	360.5	444.0	527.0	212	6° 51′
37	12.2	"	"	"	"	"	"	111.7	195.5	278.1	361.8	445.0	528.5	266	2° 0′
75	11.6	"	"	"	"	"	"	110.8	194.2	277.3	360.5	444.5	527.5	188	6° 30′
48	13.2	"	"	"	"	"	"	111.8	195.6	278.2	361.7	445.2	529.0	322	1° 16′
Average								111.3	194.9	277.6	361.2	444.7	528.1		
Motor															136° 0′0″

TABLE 3 AVERAGE ELECTRICAL READINGS FOR EACH TEST

Test No.	Date 1908	Total Resultant Loads on Lineshaft Bearings Lbs.	Ave. Resultant Pressures on Idlers Lbs.	Total Kw. Taken from Line	Supply Pressure Volts	Ave. Armature Current Amperes	Ave. Field Current Amperes
1*A*	2/4	2349.5	111.3	1.375	111.0	10.43	1.96
1*B*	2/6			1.302	109.6	10.1	1.79
2*A*	2/4	2762	194.9	1.560	109.5	12.3	1.92
2*B*	2/6			1.372	109.5	10.75	1.78
3*A*	2/4	3261.5	277.6	1.842	109.6	14.9	1.95
3*B*	2/6			1.516	110.0	12.0	1.82
4*A*	2/4	3792.5	361.2	2.051	108.6	17.1	1.82
4*B*	2/6			1.653	110.0	13.25	1.81
5*A*	2/4	4377	444.7	2.098	110.5	17.1	1.91
5*B*	2/7			1.802	109.4	14.7	1.81
6*A*	2/4	4977	528.1	2.238	109.9	18.4	1.92
6*B*	2/7			1.933	110.0	15.8	1.78
7*A*	2/1	2000	0	0.479	110.0	4.00	0.366
7*B*	2/6			0.381	103.0	3.33	0.381
8*A*	2/4	2070	0	1.107	111.0	8.00	1.98
8*B*	2/7			0.955	110.0	6.75	1.93

Tests 7*A* and 7*B* made with 1-h.p. motor. All other tests made with 10-h.p. motor. Motor, 856 r.p.m. Line shaft 214 r.p.m.

TABLE 4 ELECTRICAL READINGS ,NEW POWER IN KILOWATTS, AND PERCENTAGE OF SAVING DUE TO BALL BEARINGS

Test No.	Total Kw. Taken from Line	Ave. Line Volts	Ave. Field Current	Ave. Field Watts	Watts Delivered to Armature	Armature and Brush Resistance Loss	Armature and Brush Drop	Load + Iron Loss at Apx. Speed	E.M.F. at 856 R.P.M. / E.M.F. in Experiment	Load and Motor Iron Los. (856 R.P.M.)	Iron Loss + Pulley Bearing Loss	Kw. Delivered to Belt at 856 R.P.M.	% Saving
1*A*	1.375	111.0	×1.96	=217	1158	11	1.0	1147	$\times\frac{106.6}{110}$	=1112	586+60	0.466	14
1*B*	1.302	109.6	×1.79	=196	1106	10	1.0	1096	$\times\frac{100.7}{108.6}$	=1016	554+60	0.402	
2*A*	1.560	109.5	×1.92	=210	1350	15	1.2	1335	$\times\frac{105.2}{108.3}$	=1297	579+60	0.660	29
2*B*	1.372	109.5	×1.78	=195	1177	12	1.2	1165	$\times\frac{100.4}{108.4}$	=1079	552+60	0.467	
3*A*	1.842	109.6	×1.95	=214	1628	22	1.5	1606	$\times\frac{106.3}{108.1}$	=1579	585+60	0.934	36
3*B*	1.516	110	×1.82	=200	1316	14	1.2	1302	$\times\frac{101.8}{108.8}$	=1218	560+60	0.598	
4*A*	2.051	108.6	×1.82	=198	1853	29	1.7	1824	$\times\frac{101.8}{106.9}$	=1737	560+60	1.117	35
4*B*	1.653	110	×1.81	=199	1454	18	1.3	1436	$\times\frac{101.4}{108.7}$	=1340	558+60	0.722	
5*A*	2.008	110.5	×1.91	=211	1887	29	1.7	1858	$\times\frac{104.9}{108.8}$	=1791	557+60	1.154	25
5*B*	1.802	109.4	×1.81	=198	1604	22	1.5	1582	$\times\frac{101.4}{107.9}$	=1487	558+60	0.869	
6*A*	2.238	109.9	×1.92	=211	2027	34	1.8	1993	$\times\frac{105.2}{108.1}$	=1940	579+60	1.301	25
6*B*	1.933	110	×1.78	=196	1737	25	1.6	1712	$\times\frac{100.4}{108.4}$	=1586	552+60	0.974	
7*A*	0.479	110	×0.366	= 40	439	48	12.0	391	$\times\frac{92.5}{98}$	= 369	76+25	0.268	21
7*B*	0.381	103	×0.381	= 39	343	34	10.1	309	$\times\frac{95.4}{92.9}$	=317	81+25	0.211	
8*A*	1.107	111	×1.98	=220	887	6	0.8	881	$\times\frac{107.3}{110.2}$	=858	590+60	0.208	65
8*B*	0.955	110	×1.93	×212	743	5	0.7	738	$\times\frac{105.6}{109.3}$	=713	581+60	0.072	

SUPPLEMENT TO TABLE 4

For 10-h.p. motor : armature resistance = 0.04 ohms, and brush contact resistance = 0.05 ohms to 0.06 ohms (2.5 sq. in.) for current densities not greater than 7.5 amperes per sq. in.; hence drop in armature and brush contact = 0.1 ohms × armature current, also loss in armature resistance and brush contact resistance = 0.1 ohms × (armature current).[2]

Iron loss = 5.5 ampères × e.m.f.

E.m.f. with 1.6 amperes in field $= (94 - 0.5)\frac{856}{850} = 94.2$; with 2.0 field amperes = $(108 - 0.5)\frac{856}{852} = 108$.

E.m.f. with any field current at 856 r.p.m. $= 94.2 + 13.8 \times \frac{\text{field current} - 1.6}{0.4}$.

For 1 h.p. motor (tests 7*A* and 7*B*): armature resistance = 2.5 ohms, and brush contact resistance = 0.85 ohm $\left(\frac{5}{16}\text{ sq. in.} \times \frac{1}{2}\right)$, only half of brush in contact; drop in brush contact for 4 amperes (7*A*) = 2 volts, and for 3.33 amperes (7*B*) = 1.8 volts.

Iron loss $= \left(0.80 + 0.1 \times \frac{\text{field current} - 0.35}{0.7}\right)$ e.m.f.

E.m.f. with 0.35 amperes in field $= (95 - 0.8 \times 3.35)\frac{856}{884} = 89.4$ volts; with 0.42 field current $= (109 - 3.1)\frac{856}{880} = 103$ volts.

E.m.f. with any field current $= 89.4 + 13.6 \times \frac{\text{field current} - 0.35}{0.7}$.

improper excessive friction in the loose pulley hubs, particularly during the "B" runs. The pressure on the smallest countershaft pulley bearing surface during these tests, Nos. 5 and 6, rose to 124 lb. and 148 lb. per sq. in. of projected area, respectively, which are excessive values.

28 Tests 7 and 8 were with all the belts off and the line shaft journals consequently sustaining only the weight of the shaft and pulleys and the pull of the one driving belt. The great discrepancy between a saving of 21 per cent and 65 per cent for apparently similar conditions needs explanation. Test 7 was made with a small 1-h.p. motor; for test 8 the same 10-h.p. motor used for the other tests was employed. On subsequent examination it was found that the small motor bearings were badly in need of oil and quite hot. A no load reading of this motor showed 250 watts, which dropped to 100 watts after oiling, a difference of 0.15 k.w. Deducting this from the readings of 0.268 and 0.211 gives 0.118 and 0.061, the latter representing a saving of 52 per cent which compares reasonably well with test 8.

DERIVATION OF CONSTANTS FOR USE IN ESTIMATING LOSSES

29 While the conditions of loading in this series of tests certainly include those of general practice and it may thus be safely inferred that the savings here shown may be generally realized, it is still desirable to derive constants that may be applied to any set of conditions.

30 The losses incurred are: Line shaft journal friction; countershaft journal friction; belt slip and resistance to bending; belt and pulley windage. The last two may be safely neglected as not being a serious percentage of the total power losses under the average shop conditions although they may become a serious percentage under very light loads.

31 For good ball bearings the coefficient of friction is known to be close to 0.0015. For plain bearings the coefficient of friction may be taken at an average value of 0.03 under good conditions. For plain countershaft bearings the coefficient of friction may also be taken at an average value of 0.03 under good conditions.

32 Under the conditions of this test the countershaft bearings were replaced by the hubs of loose pulleys on the swings. With the very primitive oiling conditions and the rather high pressures the coefficient of friction here may be safely taken as high as 0.08.

Let L = load in pounds.
d = shaft. diameter in inches.
S = shaft speed in r.p.m.
μ_p = 0.03 = coefficient of friction for plain ring oiling bearings.
μ_l = 0.08 = coefficient of friction for loose pulley bearings.
μ_b = 0.0015 coefficient of friction for ball bearings.
kw. = power consumed in kilowatts.

$$\text{Kw.} = \frac{0.746 \pi d L S \mu}{12 \times 33000}$$
$$= 0.000{,}0059\, L d s \mu$$

and for $d = 2\frac{7}{16}$ in., $S = 214$; Kw. $= 0.00308\, L\mu$.

33 This works out for the various total loads (Table 4) of the six tests:

LINE SHAFT LOSSES IN KILOWATTS

Load in pounds	2350	2762	3262	3793	4377	4977
Plain Bearings, Kw	0.217	0.255	0.301	0.350	0.405	0.460
Ball Bearings, Kw	0.011	0.013	0.015	0.018	0.020	0.023

34 The loose pulleys on the countershafts had various diameters and speeds, given in Fig. 2. The sum of the products of these corresponding diameters and speeds is 3060. For this, kw. = 0.018 $L\mu$. This works out for the various average loads (Table 5) of the six tests:

COUNTERSHAFT LOSSES IN KILOWATTS

Loads in pounds	111.3	194.9	277.6	361.2	444.7	528.1
Countershaft, Kw	0.160	0.280	0.400	0.520	0.640	0.760

35 Adding these countershaft losses to the plain and then to the ball bearing losses above gives

TOTAL LOSSES

Plain Bearings, Kw	0.377	0.535	0.701	0.870	1.045	1.220
Ball Bearings, Kw	0.171	0.293	0.415	0.538	0.660	0.783

COMPARISON OF ACTUAL AND CALCULATED LOSSES

36 In order to make convenient comparisons of these calculated losses with those found by measurement they are tabulated and compared as follows:

TOTAL LINE AND COUNTERSHAFT POWER SAVINGS COMPARED

Tests	1	2	3	4	5	6
Plain bearings, calculated, Kw	0.377	0.535	0.701	0.870	1.045	1.220
Ball " " "	0.171	0.293	0.415	0.538	0.660	0.783
Calculated savings due to ball bearings, Kw	0.206	0.242	0.286	0.332	0.385	0.437
Savings expressed as per cent	55	45	41	38	37	36
Plain bearings, measured Kw	0.466	0.660	0.934	1.117	1.154	1.301
Ball " " "	0.402	0.467	0.598	0.722	0.869	0.974
Measured savings due to ball bearings Kw	0.064	0.193	0.336	0.395	0.285	0.327
Savings expressed as per cent	14	29	36	35	25	25

37 A comparison of the calculated per cent of saving with the measured per cent of saving as given in the preceding table shows a fair correspondence in tests 3 and 4 but a considerable divergence for tests 1—2—5—6. Now 1 and 2 are for very light loads and the difference may probably be accounted for as due to the neglected belt resistances and windage. As these are constant and probably independent of the load, they are a large factor for light loads and less so for heavier loads.

38 Tests 5 and 6 showed abnormal losses in the countershafts, accounted for by serious overheating of the loose pulley hubs.

CONCLUSIONS FROM TESTS MADE UNDER NORMAL BELT CONDITIONS

39 Fortunately tests 3 and 4 were made under conditions of normal belt tensions of 44 and 57 lb. per inch width of single belt and so indicate that the

a Savings due to the substitution of ball bearings for plain bearings on line shafts may be safely calculated by using 0.0015 as the coefficient of ball bearing friction, 0.03 as the coefficient of line shaft friction, and 0.08 as the coefficient of countershaft friction.

b When the belts from lineshaft to countershaft pull all in one direction and nearly horizontally the saving due to the substitution of ball bearings for plain bearings on the lineshaft may be safely taken as 35 per cent of the bearing friction.

c When ball bearings are used also on the countershafts the savings will be correspondingly greater and may amount to 70 per cent or more of the bearing friction.

d These percentages of savings are percentages of the friction work lost in the plain bearings; they are not percentages of the total power transmitted. The latter percentage will depend upon the ratio of the total power transmittted to that absorbed in the line and countershafts.

e The power consumed in the plain line and countershafts varies, as is well known, from 10 to 60 per cent in different industries and shops. The substitution of ball bearings for plain bearings on the line shaft only, under conditions of paragraph "*a*" will thus result in savings of total power of $35 \times 0.10 = 3.5$ per cent to $35 \times 0.60 = 21$ per cent. By using ball bearings on the countershafts, also the saving of total power will be from $70 \times 0.10 = 7$ per cent to $70 \times 0.60 = 42$ per cent.

EXPENDITURE REQUIRED TO EFFECT POWER SAVING

40 While power saving is of interest and desirable the man responsible for the earning of dividends will want to know what it costs to bring about such power saving and what the investment involved will pay.

41 A reference to the bearing cost of this test will give the answer.

Ten $2\frac{7}{16}$-in. by 16-in. drop ball bearing hangers, ocmplete cost		$212.60
Ten $2\frac{7}{16}$-in. by 16-in drop ring oiling hangers, complete cost		84.00
Extra investment		$128.60
Value of saving of 0.395 kw. at 3 cents per kw.-hour for 3000 hr. per year		$35.50
(Conditions of test No. 4 representing average)		
This saving represents on the extra investment		27 per cent

A closer calculation, taking into account all of the elements, shows a still better result:

First cost, plain bearing installation, $84.00		
Depreciation at 20 years	$4.20	
Maintenance Oil; ½ pt. per day at 20 cents per gal	3.75	
Labor, 2 hr. per week at 20 cents	20.80	
Total		$28.75
First cost ball bearing installation, $212.60		
Depreciation at 20 years	10.13	
4 per cent interest on first cost difference	5.15	
Maintenance:		
Oil, 1 gal. per year	.20	
Labor, 5 hr. once per year	1.00	
Total		16.48
Difference		$12.27
Value of power saving of 0.395 kw. at 3 cents per kw.-hr. for 3000 hr.		35.50
Annual saving total		$47.77

Annual saving as return on extra investment of $128.60 = 37 per cent

AN ELECTRIC GAS METER

By Prof. Carl C. Thomas, Madison, Wis.
Member of the Society

The meter described in this paper is designed for measuring the rate of flow of gas, air or steam. The operation of the meter depends upon the principle of adding electrically a known quantity of heat to the gas and determining the rate of flow by the rise in temperature of the gas between inlet and outlet of the meter. This principle lends itself to the operation of a meter possessing the following characteristics:

a There are no moving parts inside the meter or in contact with the gas.

b The accuracy of the meter and its sensitiveness are independent of the rate of flow of gas, and of fluctuations in pressure and temperature.

c The meter may be used to measure gas at high pressure as well as at low pressure, and is independent of small fluctuations in pressure, such as those in the discharge from an air compressor or in the suction of a gas engine.

d The meter produces a continuous autographic record showing the rate of flow and its variation.

e Meters of comparatively very small size have very large capacity.

f The meter may be opened for inspection, for blowing out accumulated matter with an air blast, or for washing with gasolene, and it can be dismantled to any extent desired without interfering with the operation of the plant.

2 Fig. 1 shows the meter as constructed for gas or air measurement, and Fig. 2 shows the exterior of the meter, of which Fig. 1 is a section. The meter consists of two parts, first, the measuring element *A* (Figs. 1, 3 and 4), through which all the gas passes when the

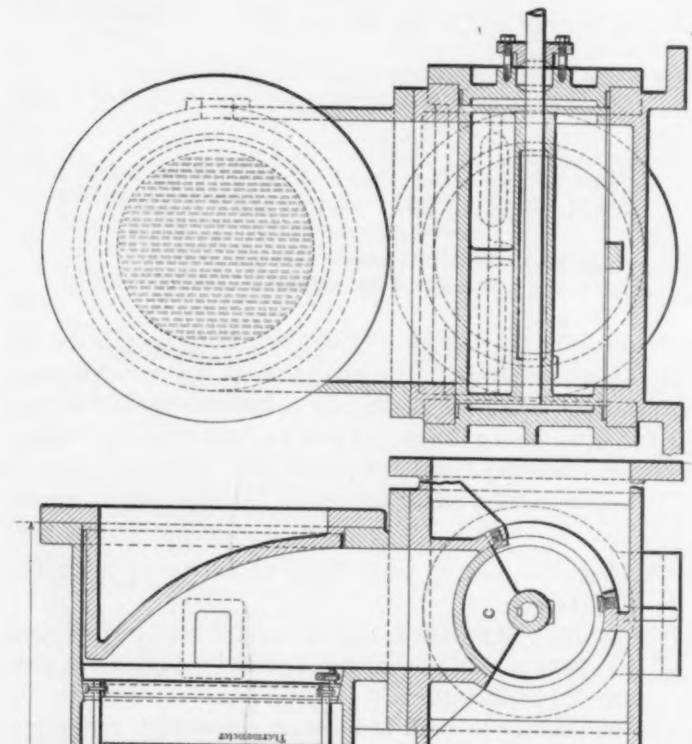


FIG. 1. LONGITUDINAL AND CROSS SECTIONS OF ELECTRIC GAS METER, SHOWING CONSTRUCTION FOR MEASURING AIR OR GAS

meter is in operation; and second, a by-pass, B (Fig. 1), so arranged that the meter can be readily cut off from the gas main by operation of the valves C, when it is desired either to operate without the meter for the purpose of inspecting or cleaning out, or to cut the meter out altogether for any reason. In certain classes of gas work, rolling valves, such as are shown at C, have been found to give trouble, while in other classes of work they are satisfactory. The gate valves customarily used in gas work can be substituted for rolling valves as occasion requires, and the by-pass can be made up of ordinary pipe and fittings instead of being a part of the meter.

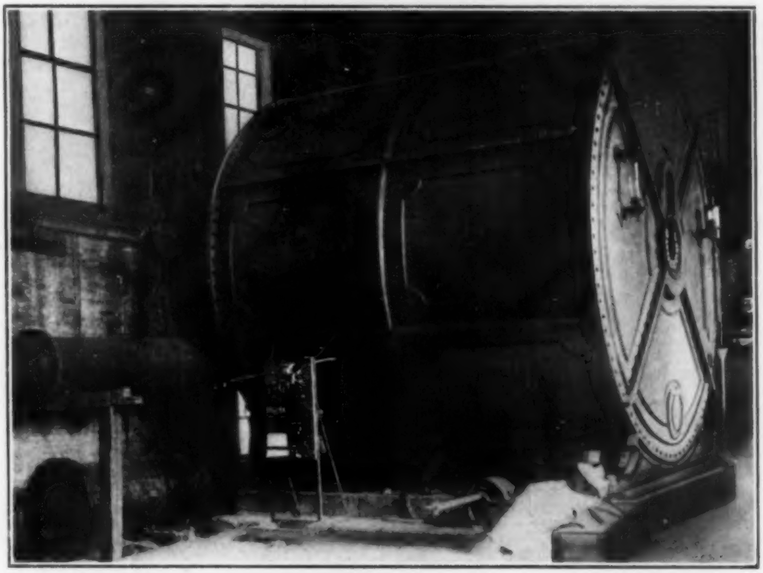


FIG. 2 VIEW SHOWING THE COMPARATIVE SIZE OF THE THOMAS ELECTRIC GAS METER (AT THE LOWER LEFT-HAND CORNER) AND THE ORDINARY WET GAS METER OF THE SAME CAPACITY

3 The meter consists of an electric heater D (Fig. 1 and Fig. 4), formed of suitable resistance material disposed across the gas passage in such a way as to impart heat uniformly and at a regular rate to the gas passing through the meter. The temperature of the gas is thus raised from that at entrance to some higher exit temperature, and the rise of temperature is measured and autographically recorded by means of the two electrical resistance thermometers E (Fig. 1 and Fig. 4), on the two sides of the heater.

4 These thermometers consist of wire wound upon vertical tubes so disposed as to come in contact with all the gas passing through the meter, thereby indicating the average temperature over the cross section of the gas passage. The fifteen tubes shown at the right of Fig. 1, and also shown in Fig. 3 and Fig. 4, extending in a vertical direction over the cross-section of the meter, support the resistance wire of the thermometers so as to afford a rugged construction. These

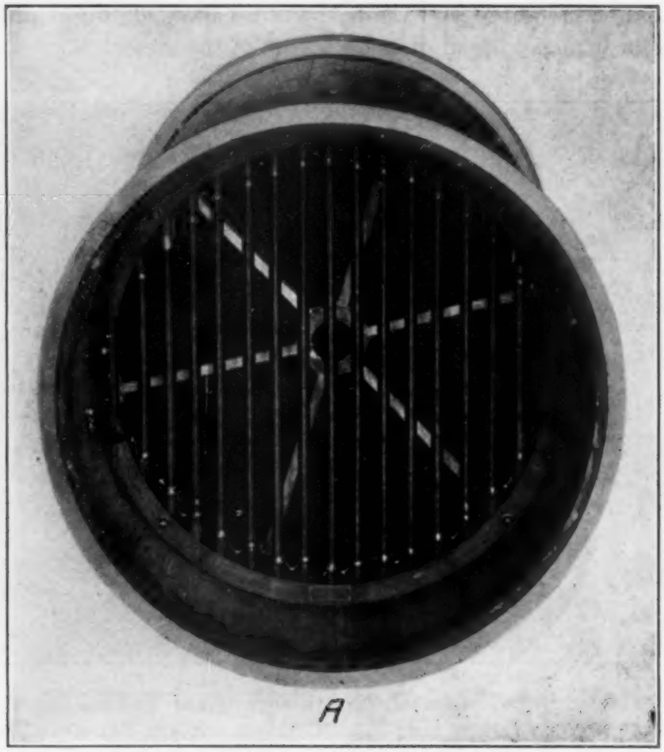


FIG. 3 HEATER UNIT AND ONE OF THE RESISTANCE THERMOMETERS

thermometers are connected to a recorder (Fig. 2 and Fig. 5), which draws a line on a chart and thus indicates the difference of temperature between the two thermometers.

5 A typical diagram is shown in Fig. 6 This diagram represents a gas flow of from 90,000 to 85,000 cu. ft. per hr., taken during a portion of the day when the fluctuation in flow is small, but nevertheless

continuous. Every small fluctuation in quantity of flow is recorded on the diagram.

6 The diagram in Fig. 7 was made during a period in which the flow varied extensively, the smallest amount recorded being about 17,000 cu. ft. per hr., increasing to 45,000, then to 62,000, to 75,000, the record ending at a flow of about 32,000 cu. ft. per hr.

7 The record in Fig. 6 was made with a temperature difference of about 4 deg. fahr. between the two thermometers, and an energy input of approximately 2 kw. The energy input when the record

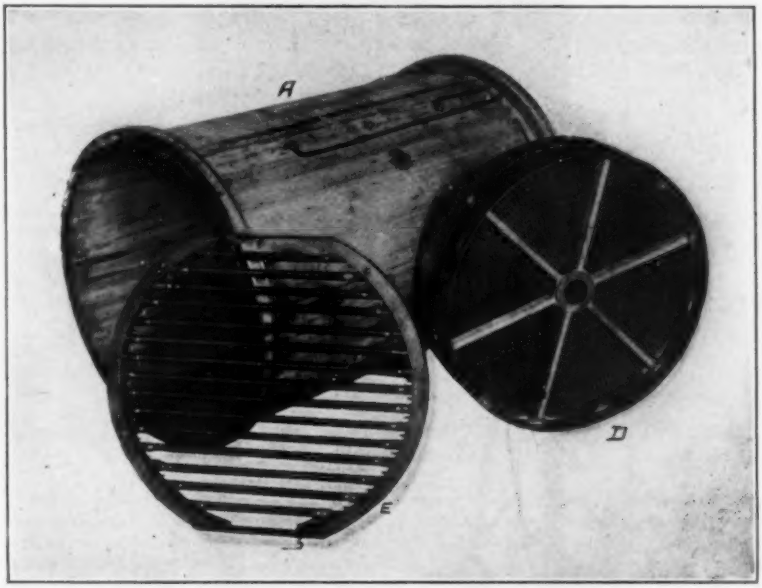


Fig. 4 Showing Construction of Heater and Thermometers

in Fig. 7 was made was approximately 1.15 kw. Fig. 6 is a typical record for a meter of normal capacity of 100,000 cu. ft. per hr., with an electric input of 2 kw.

8 The principle underlying the measurement of gas by this means is as follows: If gas is flowing through the heater at a given uniform and constant rate, and if heat is being supplied electrically, and imparted to the gas at a constant rate, a certain definite rise of temperature will be produced in the gas during its passage between the two thermometers and through the heater, and this constant difference

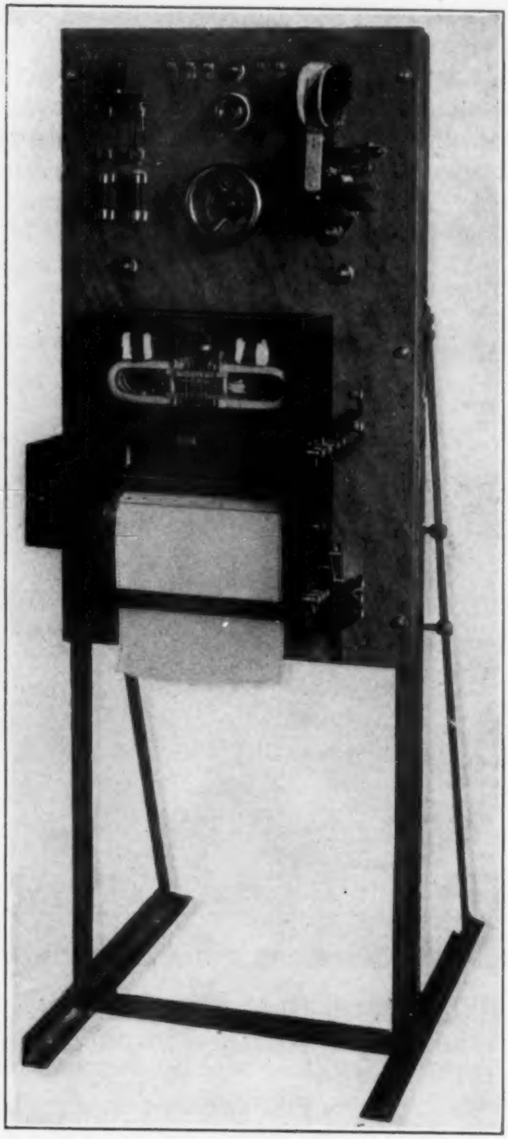


Fig. 5 Recording and Operating Instrument

of temperature will be maintained so long as the amount of gas passing per unit of time is constant. But if the quantity of gas passing per unit of time diminishes, the heat supplied at the same constant rate as before will raise the temperature of the gas by a greater amount than was the case when a larger quantity of gas was flowing and absorbing the energy liberated by the heater. Conversely, if the rate of flow increases, the energy being supplied to the heater and delivered to the gas will not be able to raise the temperature by as great an amount as when the rate of flow was less. The temperature difference produced by a known input of electrical energy thus forms a measure of the quantity of gas flowing through the meter.

9 The meter may be operated in either one of two ways, of which the first is as follows: the difference of temperature between inlet and

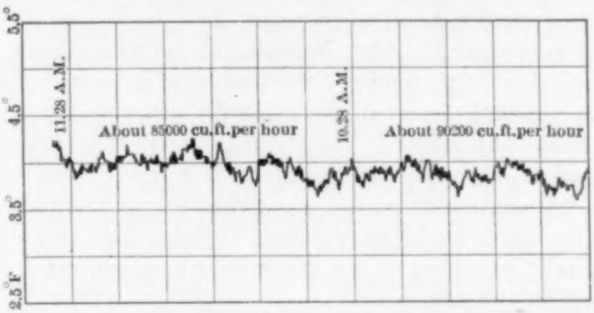


Fig. 6 Autograph Record Showing Gas Flow of about 87,000 cu. ft. per Hour

Note: This diagram was taken under approximately steady conditions of flow during the regular operation of one of the plants of the Milwaukee Gas Light Company. The paper in this case was traveling at a rate of 3 in. per hour. The recorder can be set for any one of three speeds of paper, 3 in., 6 in., or 12 in. per hr. The higher speeds are desirable as they smooth out the curve of temperature differences. The scale of temperature differences can also be greatly enlarged if desired.

outlet is kept constant, and the watts required to maintain this constant difference of temperature vary directly as the weight of flow. The watts input thus forms the measure of the weight of flow of air or gas, the watts being measured by a recording wattmeter, or in some cases by an integrating wattmeter. The fixed difference of temperature (about 5 deg. fahr.) is maintained by the action of a device made upon the same principle as the well-known autographic temperature recorders used in connection with resistance thermometers, but without the autographic part.

10 The mechanism which actuates the pen carriage in the autographic recorder is so arranged that when the carriage tends to depart from the straight-line path indicating a constant difference of temperature it automatically cuts in and out the resistance necessary in order to maintain the fixed difference of temperature. This variation of energy input is accomplished by a small motor-controlled rheostat mounted on the switchboard. Thus as the rate of flow of gas is increased, the temperature difference tends to decrease, and at once additional energy is introduced sufficient to heat the increased weight of gas so as to maintain the constant temperature difference. This method of operation is advantageous because it does not require the maintenance of a constant voltage on the line supplying the energy for heating the gas. The accuracy is thus independent of the small fluctuations in voltage generally found on electric supply circuits.

11 The second method of operation involves the use of the autographic temperature recorder, including the graphical part, the diagram from which, representing the variation of difference of temperature with constant energy input, gives the measure of the quantity of gas passing the meter. That is, the electrical resistance of the meter remains constant, and the meter is supplied with current at constant voltage, which results in constant energy dissipation in the meter. The difference of temperature between inlet and outlet then rises and falls according to the decrease or increase, respectively, of the rate of flow of gas.

12 The first method of operation mentioned is superior to this second method, inasmuch as the first is independent of any change which might take place in the electrical resistance of the material composing the heater. Operation by the second method requires that constant voltage be maintained across the line, and that the electrical resistance of the heater shall remain constant, or else that both watts input and temperature difference shall be recorded. In the experimental work of developing the meters it has been found convenient to use this second and more cumbrous method, but in meters at present under construction the first-mentioned method has been adopted, thus avoiding the necessity for either constant voltage or constant resistance, and resulting in simpler apparatus throughout. A record of the watts input is, by the method now used, all that is required for determining the flow of gas through the meter. The meters can be arranged to operate with either direct or alternating current, and the controlling device can be arranged to work with any desired voltage.

13 Fig. 2 shows, at the lower left-hand corner, an electric gas meter together with its autographic recorder and switchboard control. This electric meter is used for measuring all of the gas which was formerly passed through the large wet meter shown in the figure, and is of sufficient capacity to enable it to measure about three times the amount of gas for which the wet meter is suited. The electric meter was placed in this position between a 100,000 cu.ft. gas holder and the large station wet meter, for the purpose of calibrating the electric meter and comparing the results, based upon the rate of drop of the gas holder, with the readings of the wet meter. The curve obtained from the autographic recorder was thus interpreted by means of the calibration carried on in connection with the gas holder, the wet meter and a meter prover of the largest size made. It was found that the wet meter used in this case was exceedingly accurate. It had been carefully put in order and calibrated before these tests, and when operated at loads within its capacity, the readings were entirely reliable. The best evidence of this is given by the results used in plotting Fig. 8.

14 The specific heat of a given kind of gas appears to be very nearly constant, since those constituents which vary from time to time are not those which appreciably affect the value of the specific heat. But it is desirable to calibrate the meters with a gas having the same specific heat as the gas which it is intended to measure in a particular case. The specific heat of illuminating gas is very closely 0.020 per cu. ft. at atmospheric pressure, as shown by Fig. 8 and also by the following calculation based upon a fairly typical analysis. Such variation as commonly occurs in the relative amounts of the various constituents does not materially affect the specific heat.

	Vol. cu. ft.	Weight per cu. ft., lb.	Total Weight lb.	Specific Heat per lb.	Specific Heat per cu. ft.
CO_2	0.04	0.11637	0.004658	0.216	0.00100
C_2H_4	0.11	0.0741	0.00815	0.404	0.00329
O_2	0.001	0.08463	0.00085	0.217	0.00023
CO	0.331	0.07407	0.02450	0.245	0.00600
CH_4	0.1761	0.04234	0.00746	0.593	0.00442
H_2	0.303	0.00530	0.00160	3.409	0.00546
N_2	0.0389	0.07429	0.00289	0.244	0.00071
					0.02111

15 The specific heat of blast-furnace gas is practically the same as that of atmospheric air, and the same is true in a general way regard-

ing producer gas. Thus, taking the following as an average analysis of blast-furnace gas, the specific heat is found to be 0.0192, while atmospheric air has a specific heat almost identical with this, or approximately 0.0191 per cu. ft. This is to be expected, since producer gas and blast-furnace gas consist principally of nitrogen and carbon monoxide.

	Vol. cu. ft.	Weight per cu. ft., lb.	Total Weight lb.	Specific Heat per lb.	Specific Heat per cu. ft.
N_2	0.60	0.0743	0.0446	0.244	0.0109
CO	0.24	0.0741	0.0178	0.245	0.0044
CO_2	0.12	0.1164	0.0140	0.216	0.0030
H_2	0.02	0.0053	0.0001	3.409	0.0003
C_2H_4	0.02	0.0741	0.0015	0.404	0.0006
					0.0192

16 The meters have been calibrated with illuminating gas and with air. A certain amount of water vapor is carried with the gas or air passing the meter. This vapor forms part of the gas or air, and is heated just as are the other constituents. The rise of temperature caused by the heat added in the meter is only a few degrees, and consequently the water vapor does not experience a change of state. The temperature of the metal forming the electric heater rises only 15 or 20 deg. fahr. above the temperature of the gas. The question of latent heat of vaporization of the water vapor therefore does not enter into the considerations underlying measurement of the gas.

17 While calibration of the meters under actual conditions of service is depended upon to obtain quantitative results, yet these meters are of such a nature that the quantity of gas or air passing through them can be very closely calculated from a knowledge of the energy input and the specific heat of gas or air. This fact, that the quantity of flow can be quite closely calculated, independently of a calibration curve, makes it possible to check the accuracy of the readings obtained.

18 The development of this meter is a result of experiments which the writer has been making for some years to determine the specific heat of gases by heating them electrically. The performance of a properly constructed heater for this purpose proved to be so entirely regular that it was apparent that the quantity of gas flowing through it could be very accurately measured by the method now used in these meters. The problem is thus the reverse of the problem of determining specific heat by measurement of the electrical energy necessary to heat the gas. It will be seen by reference to Fig. 1 that

the whole process of heating the gas and of measuring the difference of temperature between inlet and outlet, is accomplished in a relatively small space which is well insulated so far as heat losses are concerned, since the heater and thermometers are contained in a casing

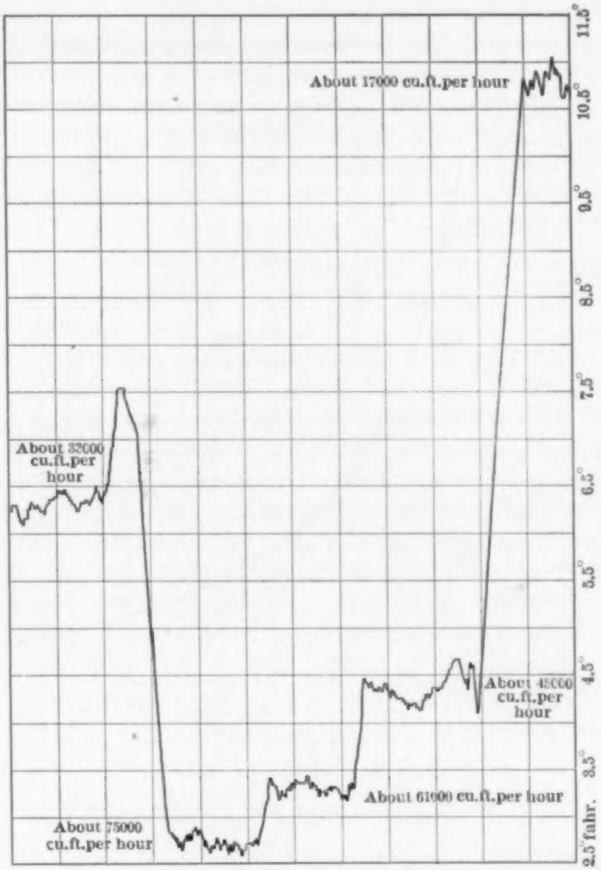


Fig. 7 Autograph Record Showing Wide Fluctuations in Flow of Gas

made of hardwood strips and separated from the metallic walls of the meter by an air space.

19 A typical calibration curve is shown in Fig. 8. The curve shows the degrees rise in temperature per kilowatt introduced when any given rate of flow through the meter is taking place. It will be seen that this curve is asymptotic to the coördinate axes, because,

when an indefinitely great amount of gas is being heated, any finite input of heat will produce only an indefinitely small rise of temperature; and on the other hand, when the amount of gas becomes indefinitely small, a finite input of heat will cause an indefinitely great rise of temperature. The calibration curves obtained are therefore rectangular hyperbolas. The product of weight of gas multiplied by degrees temperature rise per watt introduced is a constant, and this

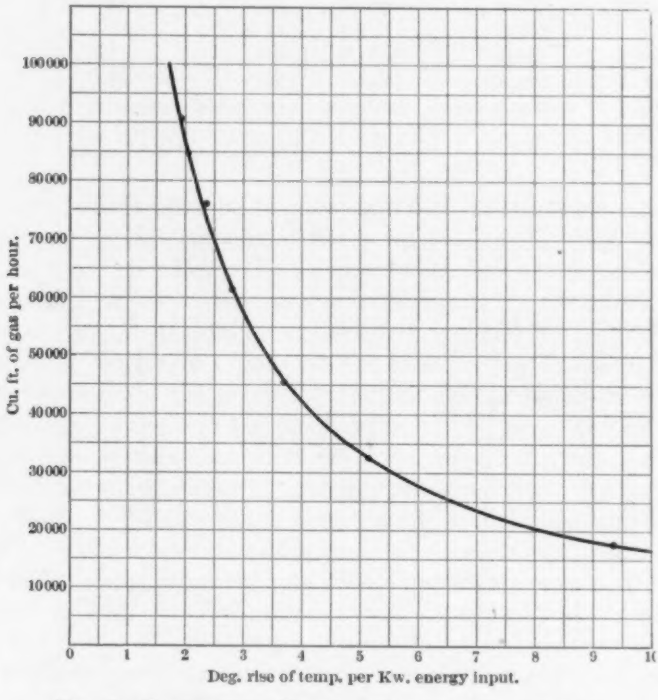


FIG. 8 CALIBRATION CURVE, SEE APPENDIX FOR DATA

constant, for a given kind of gas, takes the place of a calibration curve and renders it unnecessary to refer to a curve. The constant as shown by Fig. 8 is 170,000, showing a specific heat per cu.ft. of $\frac{3.412}{170} =$ 0.0201.

20 The accuracy of these meters is not affected by changes in pressure of the gas or air, since the unit of measurement is that of weight rather than of volume; that is, the meter takes cognizance of

the specific gravity, or the amount of "stuff" in a given volume of the gas. Also variation of temperature of the incoming gas does not affect the accuracy, because it is a difference of temperature, rather than a fixed temperature, upon which the measurement depends. The meter can be used for gas or air at either high or low pressure, and at either high or low temperature, provided the materials used in construction are suited to the conditions.

21 This method of measuring gas seems especially useful in connection with engines operated by gas from producers, blast furnaces, etc., and in measuring the discharge of gas or air from compressors, because the small and rapid periodic fluctuations of pressure, due to the suction of gas engines or to the discharge from compressors, do not interfere with the steady action of the thermometers. The time lag of the latter is sufficient to smooth out the curve of temperature variation, or of watts input, as the case may be, and true average results are thus indicated.

22 The temperature difference employed when operating with a constant difference, is approximately 5 deg. fahr. When a curve of temperature difference is employed, the temperature rise is from 4 to 5 deg. fahr. when the normal maximum amount of gas is flowing. This difference may be increased to 10 or 12 deg. when the rate of flow is greatly diminished, and at 100 per cent overload the temperature difference is from 2 to 2½ deg. On the autographic record one inch represents a temperature difference of one degree. The thermometers and recording device are such as to render the records accurate within 1 per cent. The minute fluctuations shown by the curves on Fig. 6 and Fig. 7 are produced by the constantly varying rate of flow in the gas mains. These can be "damped out" to any extent desired. The apparatus with which this record was taken was purposely made sensitive to minute fluctuations.

23 The electrical energy required to operate the meters is approximately 1 kw. per 50,000 cu.ft. hourly capacity. The curves shown in Fig. 7 represent variations of from 17,000 to 75,000 cu.ft. per hr., and were made with an energy input of approximately 1.15 kw. To provide for more gas and still have the record lie conveniently on the paper, it is only necessary to increase the energy input by manipulation of the rheostat hand-wheel on the switchboard.

24 The meters are so constructed that the heads can be easily removed and an air blast used for cleaning out the interior, or the entire casing, containing heater and thermometers, can be removed and dipped in gasolene for the purpose of removing tar or other deposit.

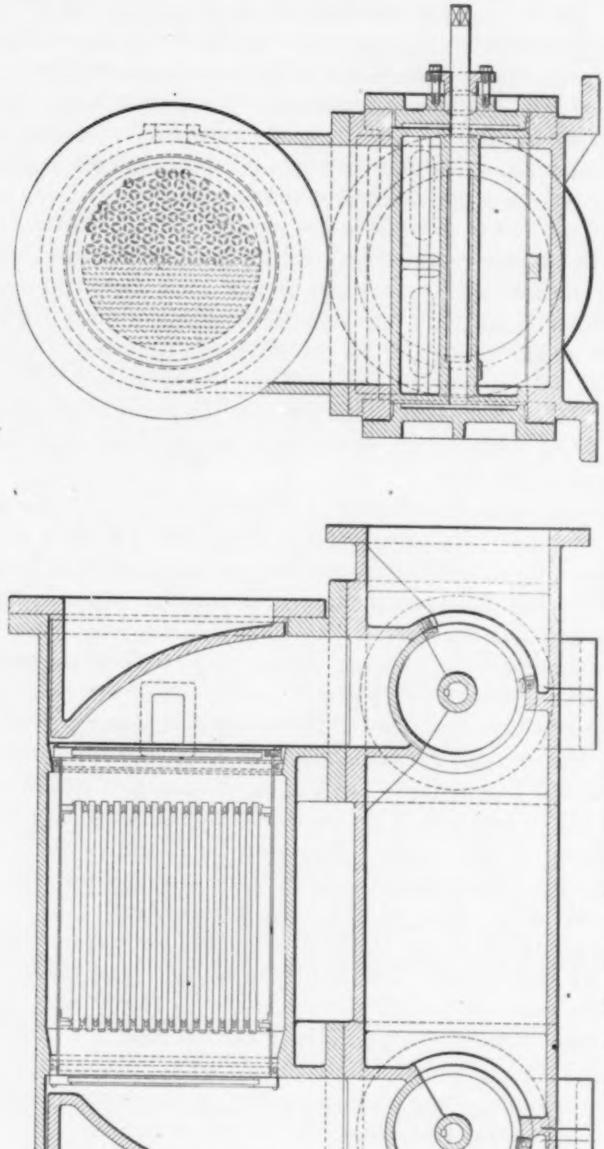


FIG. 9 METER AS ARRANGED FOR MEASURING EITHER QUANTITY OR QUALITY OF STEAM

All parts of the meter are of rugged construction, and are of well-developed materials familiar to engineers. The heater units consist of corrugated strips of resistance ribbon about 1½ in. wide, wound spirally into discs of such diameter as to fit the inside of the wooden casing. The number of these discs depends upon the capacity of the meter. The heater shown in Fig. 4 consists of two discs.

25 The same type of meter, modified as shown in Fig. 9, can be used for the measurement of steam, and also for determining the quality or percentage of moisture of steam. When used for measuring the quantity of steam, the steam is first superheated slightly in a superheater of the ordinary type, after it leaves the boilers and before passing through the meter.

26 The heater element in the steam meter consists of tubes, as shown in Fig. 9, made of suitable resistance material and supported on insulating bushings in the tube plates, the construction being similar to that of a surface condenser. The slightly superheated steam is passed through and around these tubes, and is further heated by the electrical energy supplied to the tubes.

27 The difference of temperature produced by a given energy input forms a measure of the weight of steam flowing, just as has been described in the case of the gas meter. In cases where it is desired to make engine or turbine tests with unsuperheated steam, the steam can be reduced in temperature after passing the meter, by the injection of a spray of water. Of course the measurement of superheated steam is simpler than is the case where superheating is not a feature of the regular operation of the plant.

28 The amount of moisture carried by steam can be very accurately determined with this apparatus, by passing all of the steam through the electrical heating material and noting the amount of energy required to "fry out" the water and cause superheating to commence. The pointer over the dial of the instrument connected with the resistance thermometer in the outlet of the calorimeter indicates when the temperature of the steam begins to rise. It is proable that the only way to determine accurately the quality of wet steam is to pass all of the steam, and not a small sample, through a calorimeter. It is of course not always practicable to do this, and in such cases it is necessary to use smaller calorimeters and to sample the steam.

29 When inserted for either regular or intermittent use as a steam meter or as a calorimeter, the device can be cut off from the steam line in the manner already described for the gas meter, and as shown in Fig. 1.

30 The automatic recording device for the gas meter is so arranged that in case the flow of gas should be interrupted for any reason the current is automatically cut off at the switchboard. Also if the flow of gas becomes so small in amount that the pen reaches within a half inch of the edge of the paper, the current is cut out. When the gas has cooled the heater slightly, the current is automatically cut in again, and if the gas flow is increased the pen goes back toward the middle of the diagram and operation proceeds normally. If the gas flow continues but does not increase beyond that at which the current was cut out, the pen will "hunt" back and forth near the edge of the paper. It can be brought back toward the middle of the paper by the introduction of more energy to the meter. The gas meter is thus fully protected from possible injury due to the complete shutting off of gas supply.

31 At the other edge of the paper, representing the maximum flow of gas, the operation is similar to that already described. In order to bring the recording pen upon the range again the electrical input is increased by manipulation of the hand-wheel on the switchboard. This applies to operation by the second method described in Par. 11, in which the temperature difference between the two thermometers forms the record of gas flow. When the first method is employed, that of maintaining constant temperature difference, the meter is also automatically protected by the motor-controlled rheostat, and the range of the instrument is unlimited and it does not require manipulation by hand. It will be seen by reference to Fig. 7 that the range of the instrument when operated by the second method of varying temperature difference, is very wide, and takes care of extensive fluctuations of gas flow.

APPENDIX

DATA RELATING TO CALIBRATION CURVE, FIG. 8

Time	Wet Meter Reading	Cu. Ft. Gas Per Hr.	Average Temperature Difference Deg. Fahr.	Average Kilowatts Input	Deg. Temp. Rise Per 1000 Watts
A.M.					
10-05	90148.0				
10-10					
10-15	90177.5				
10-20	90192.0	17350	10.7	1.153	9.30
10-25	90206.0				
10-30	90220.5				
10-50	90396.0				
10-55					
11-00	90470.0				
11-05	90509.0	45200	4.25	1.150	3.60
11-10	90546.0				
11-20	90644.0				
11-25	90695.0	61200	3.25	1.160	2.80
11-30	90746.0				
11-40	90884.0				
11-45	90947.0	75600	2.70	1.160	2.32
11-50	91010.0				
P.M.					
12-05	91098.0				
12-10	91125.5				
12-15	91152.7	32640	6.25	1.22	5.12
12-20	91180.0				
12-25	91206.8				
A.M.					
9-30	91418.2				
9-35	91493.4	90240	3.90	2.05	1.90
9-40	91568.8				
9-45	91643.8				
10-00	91857.1				
10-15	92074.0				
10-30	92291.7				
10-45	92506.2	84960	4.10	2.05	2.00
11-00	92717.5				
11-15	92925.4				
11-30	93131.0				

BITUMINOUS GAS PRODUCERS

WITH SPECIAL REFERENCE TO TESTS ON THE DOUBLE ZONE TYPE

By J. R. Bibbins, New York
Member of the Society

Several manufacturers have seriously applied themselves for years to perfecting the bituminous producer. The problem has been difficult and success elusive; but the improvements of the last two or three years have been material, and likely to lead to a type universally acceptable as standard. Outside of the question of pecuniary reward, much credit is due to these manufacturers for persevering against material obstacles and personal prejudice, and at an expense ruinous to any but those possessing large resources.

2 It is the object of this paper to record the results of the most recent achievements in this direction, and to interpret them in the light of personal experience. No attempt is made to discuss the commercial aspect, and in this respect the results presented will largely be left to speak for themselves. These results are drawn from resources accurate and reliable in so far as commercial tests can be made to approximate scientific investigation. Beyond this no claims can be made for refined accuracy.

ESSENTIAL REQUIREMENTS

3 Successful operation of a modern gas engine generating station prescribes certain requirements in the producer plant:

a Continuous operation, 365 days per year. Any departure from this condition means reserve equipment, additional capital outlay and idle plant. Producer designers cannot escape at this advanced stage of the art a condition parallel to that of steam boiler practice. For this continuous service the water-seal has proved adequate, but

All papers are subject to revision.

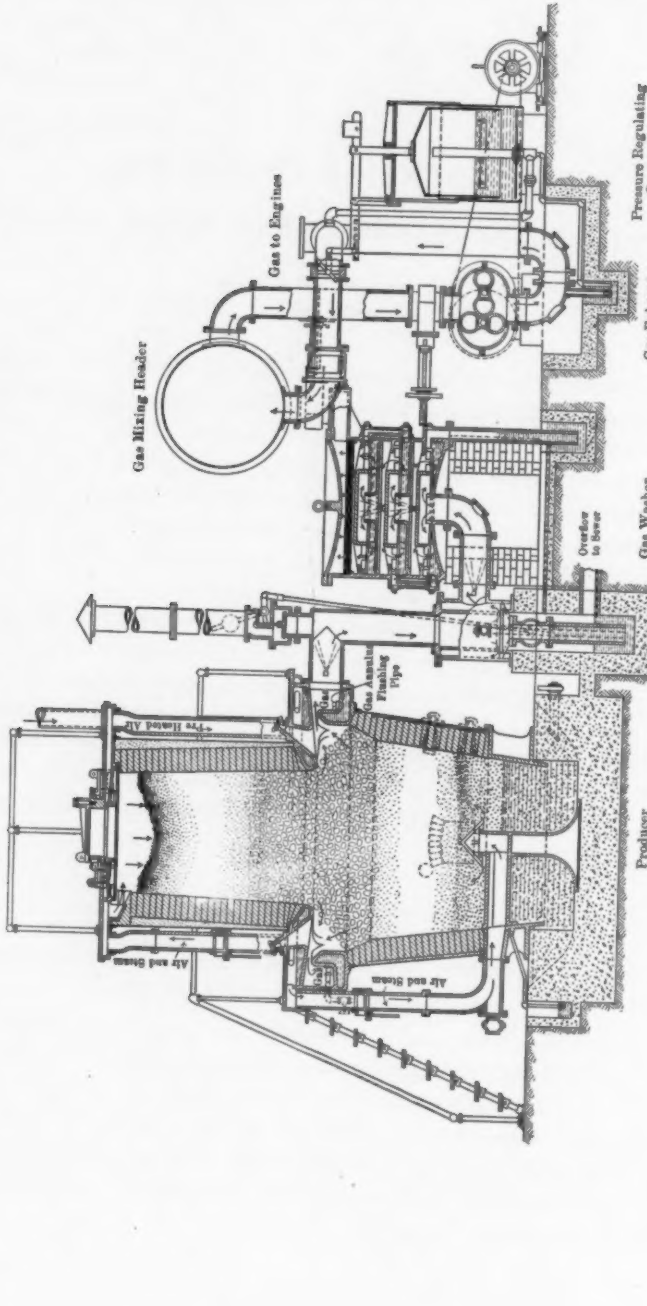


FIG. 1 SECTIONAL VIEW OF PRODUCER AND AUXILIARY APPARATUS

some means of mechanically removing ash should be developed.

b Plant suited to various kinds of fuels without remodeling, such as change of grates, etc. Fortunately gas producers are unusually flexible in this regard.

c Gas clean and free from tar. No engine design except perhaps some one of the simple valveless types can withstand the action of viscous tar deposits on the valve seats. Mechanical extraction can hardly be considered an acceptable remedy in this regard.

d Moderate labor requirements. No design will last which requires excessive attendance and large periods of shutdown for cleaning or repair.

e Prevention of clinker formations. Both labor cost and the uniformity of gas production are affected seriously by clinker. The obvious remedy is relatively low fuel bed temperatures.

f Automatic gas regulation. Large and expensive gas holders should be unnecessary. Quantity and quality regulation of gas may be made susbtantially automatic by proper design. An essential requisite is to relieve the producer attendant of all possible adjustments, as it is next to impossible to obtain at the prevailing wage the grade of intelligence otherwise necessary. The power-driven exhauster has removed a great proportion of the disabilities of the steam blown producer.

g Minimum auxiliary apparatus. It is manifestly inadvisable to nullify the high efficiency of the producer by wasteful auxiliaries. For this reason the suction principle has come into favor. Internal vaporizers provide automatic regulation quite adequate to the usual fluctuations in demand for gas, thus dispensing with the small boiler.

DESCRIPTION OF POWER PLANT, ETC.

4 The tests herein presented pertain principally to the double zone type of producer. As a complete description of this type was incorporated in the last report of the National Electric Light Association, 1909, constructional details may be dispensed with. Fig. 1

shows the arrangement in sections, comprising the following essential parts:

Water sealed ash pit,
Lower coke gasifying zone,
Central belt evaporator,
Upper coking zone for green fuel,
Air cooled top (preheating air blast),
Charging funnel open to atmosphere,
Vapor control valves for top and bottom fires,

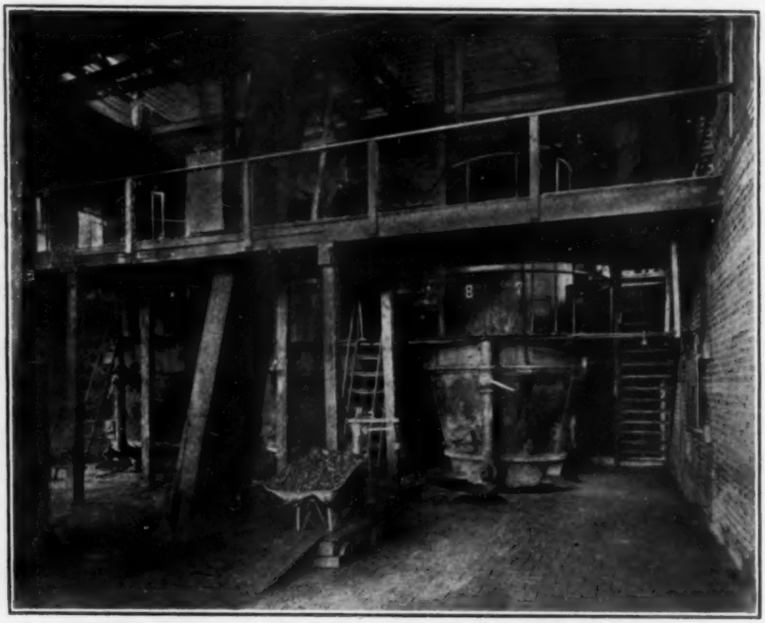


FIG. 2 525-H.P. BITUMINOUS PRODUCER PLANT, WESTERN CHEMICAL COMPANY, DENVER

Radial poke holes for raking top and bottom walls,
Static cellular washer,
Positive rotary exhauster,
Automatic by-pass regulator valve,
Regulating gasometer for maintaining constant delivery pressure to engine.

5 This system obviously works entirely by suction with the charging top at atmospheric pressure. The sole adjustment is the relative position of the vapor control valves, which are set *permanently* for any given fuel and require no change for ordinary variations in power load. These valves determine the relative rates of combustion in

the upper and lower zones, the temperatures, and the rate of settling of the two fuel beds. While the producer is not supersensitive, intelligent adjustment is necessary to secure the most uniform gas. But the gas holder is dispensed with entirely, as the production is directly proportionate to the demand, giving a constant delivery pressure at the engine.

SCHEDULE OF TESTS

6 This producer plant has been under test in commercial sizes (175 h.p.), at East Pittsburgh, since December 1907, with various fuels and under various conditions of load. Up to July 1909, a total of over 2040 hours of operating tests had been run, operating from a minimum of 47 to a maximum of 514 hours continuous tests and on both 10- and 24-hour runs. Over 266,000 lb. of coal was gasified, the fuels ranging from low grade lignites to the best Pocahontas semi-bituminous coal. Some trials were also made on meadow peat. All the gas made was tested by means of a standard three-cylinder engine of 140 h.p. operating also continuously against the resistance of a prony brake. The gas was measured by wet meters at both[1] the producer and the engine. Determinations were made regularly for calorific value by means of the Junker calorimeter; for impurities by the Sargeant filter paper method; for composition and heat value by chemical analysis. Coal was weighed on scales—not measured. Table 1 shows a complete schedule of tests; of these special tests F and G were run to determine accurately the normal standby loss; Test H to try out the type of washer shown in the sectional drawing, Fig. 1. It is apparent that this series of tests is unusually valuable in indicating results under various conditions of service. The important results follow, and are discussed *seriatim.*

DISCUSSION OF RESULTS

7 It should be noted by Table 2 that fuels containing as high as ¼ their weight of water were successfully used for power purposes. The efficiency curve (Fig. 3) fully establishes the fact that the efficiency of heat conversion is practically as high with lignites as with the cheaper fuels.

8 In the test with Texas lignite an important fact was brought out, which has especially puzzled theorists for some time, viz: That with a poor fuel the rate of combustion can be increased sufficiently to permit the same rating of the producer as with better fuel. This re-

[1]For check purposes, meter calibrated by positive holder fall.

TABLE 1 SCHEDULE OF TESTS

Test	Date.	Fuel	Duration Hours	Hr. per day	Load on Producer		Remarks
					b.h.p.	Max.	
	1908						
A	4/ 2– 4	So. Am. Lignite	72	11	....	....	Purged Gas.
B	4/16–30	Col. Lignite	314	24	121.7	156.9	Continuous Test.
C	5/ 8–23	Pittsburgh	298	24	158.3	129	" "
D	7/16–31	"	370	10	158.5	206	Intermittent test.
E	8/ 4–25	"	514	10	170.8	190.7	" "
F	9/ 1–19	"	432	Standby	.....	.....	Standby test. Fires blasted 1 hr. once in 24 hr. day
G	10/12–19	"	168	"	.....	.....	
H	11/ 9–14	"	...	10	137 to	204	Washer test and capacity test
	1909						
I	6/ 1– 2	Pocahontas	46½	22½	75.6		Continuous test.
J	6/ 3– 4	"	48	24	101.4		" "
K	6/ 5– 6	"	48	24	126.5		" "
L	6/ 7– 9	"	72	24	150		" "
M	6/30– 2	Texas Lignite	72	24	128	135	" "
N	7/ 7– 8	" "	42	24	157.2		" "

moves a heavy restraint on the development of producers for the enormous lignite fields of Texas, Wyoming, Colorado, Montana and the Pacific States. In Test *N*, Table 3, a charging rate of 27.2 lb. per sq. ft. per hr. was maintained with Texas Lignites and 15 lb. with Pocahontas, both at 150 h.p. load; with Pittsburgh run of mine it was slightly higher (18.1).

9 An economy of less than 1 lb. per brake horsepower-hour is probably below previous results with bituminous producers. This

TABLE 2 TYPICAL PROXIMATE ANALYSES OF FUELS TESTED

Class of Fuel	Moisture	Volatile	Fixed carbon	Ash	Sulphur	B.t.u. per lb. as fired	B.t.u. per lb. dry
Meadow Peat—Massachusetts..........	38.10	40.54	17.86	3.50	1.05	6410	10340
Lignite—South America...............	20.05	34.44	30.85	14.66		8035	10045
Lignite—Northern Colorado...........	16.63	33.78	42.22	7.37		9589	11500
Lignite—Texas.......................	24.08	38.55	28.76	8.61	0.57	7974	10503
Bituminous—Pittsburgh run of mine....	2.03	34.98	56.22	6.77	1.29	13305	13590
Semi-Bituminous—Pocahontas run of mine..........................	1.39	16.01	74.28	8.32		13983	14170

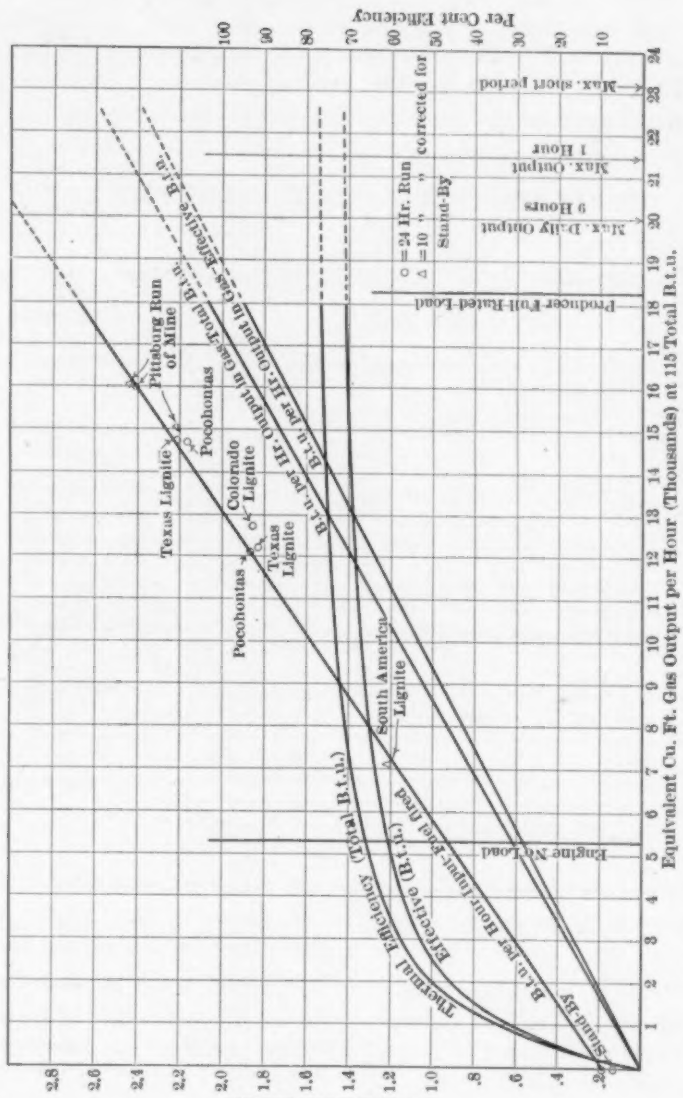


FIG. 3 EFFICIENCY TESTS, TYPE T-35 BITUMINOUS PRODUCER, WESTINGHOUSE MACHINE COMPANY

corresponds to less than 1½ lb. per kilowatt-hour in an electric generating station. An interesting point is the low standby fuel consumption, which averages in over a week's run 1 lb. per sq. ft. of fuel bed area per hour. In test G it was reduced to this amount from 1.49 lb. (Test F) simply by reducing the natural up-draught through the idle producer, by closer adjustment of the valves.

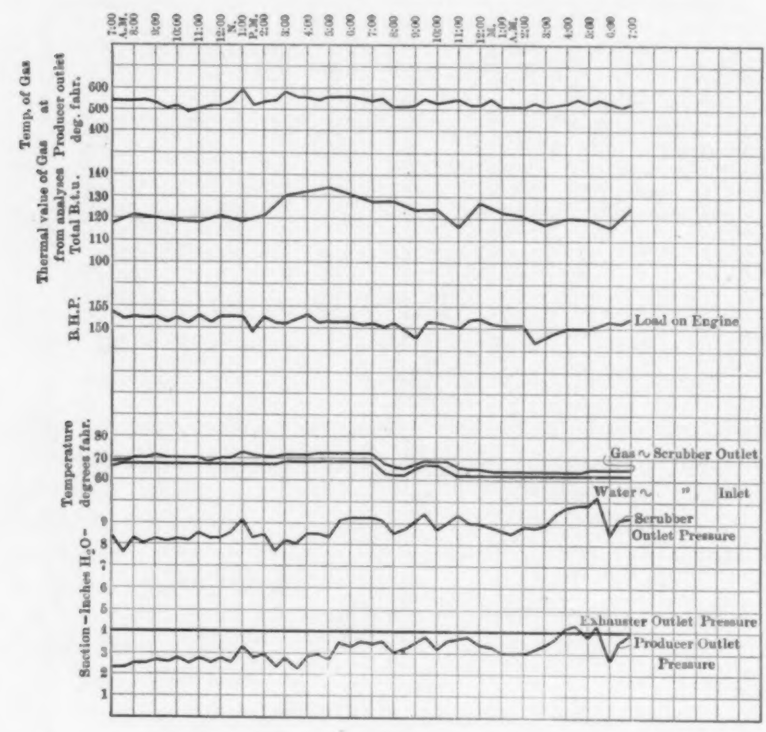


FIG. 4 TYPICAL LOG, POCAHONTAS COAL, LAST DAY OF RUN, 21½ HRS.

10 Test H, which was a capacity test, shows an 18 per cent overload on gas production maintained for nine consecutive hours with Pittsburgh run-of-mine. Test C with the same coal shows nearly 30 per cent overload.

11 In heat value the gas is not high; but more important, it is fairly uniform as shown by the typical log, Fig. 4, 5 and 6. The heat value seems to bear a certain relation to the fuel bed temperature. It is found that if a certain temperature of the gas off-take is exceeded

(about 1000 deg.), vitiation of the gas ensues from excessive combustion. The condition of the fuel bed may be readily watched by means of a pyrometer (in the discharge) and with proper adjustment of vapor and draught, temperatures may readily be held below this limit; especially with lignites.

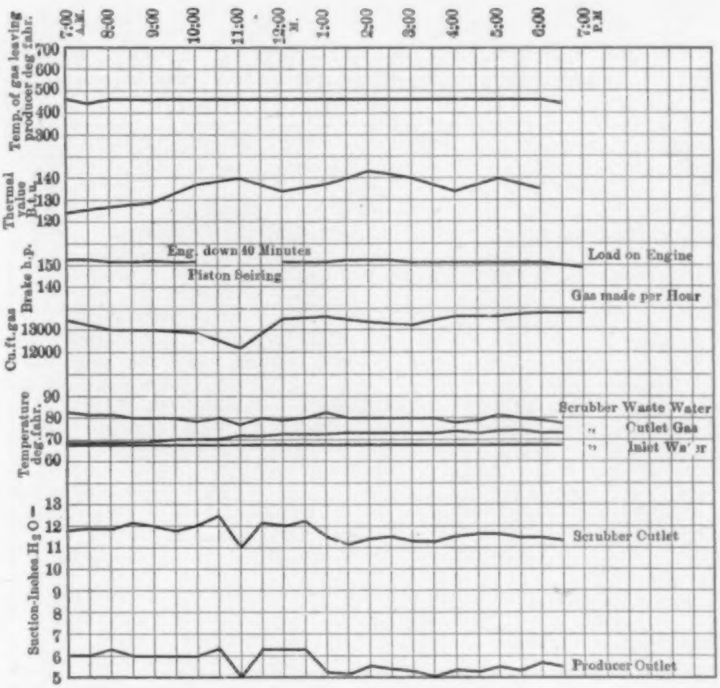


FIG. 5 TYPICAL LOG TEXAS LIGNITE, BEGINNING OF TEST

12 In this connection a comparison of these heat values with similar values from other plants is interesting, revealing the extreme range permissible with engines of modern design; see Table 10. Both are fair operating plants, but deliver gas at a considerable variation from specified value (125 B.t.u.), without occasioning any disturbance in the operation of the engine. Results from the double-zone producer show that present engine ratings are well suited to the gas, a higher compression is permissible, and that a high hydrogen content—as high as 20 per cent—does not necessarily interfere with operation.

13 Perhaps the most important result is tar-free gas. The impurities normally consist of dust and lampblack. By the filter paper method, Fig. 7, it is possible to detect the least trace of tar, which quickly discolors through to the second layer of paper. Fig. 7 shows the maximum deposit from a run on Pittsburgh coal. Note that there is no discoloration of the second paper.

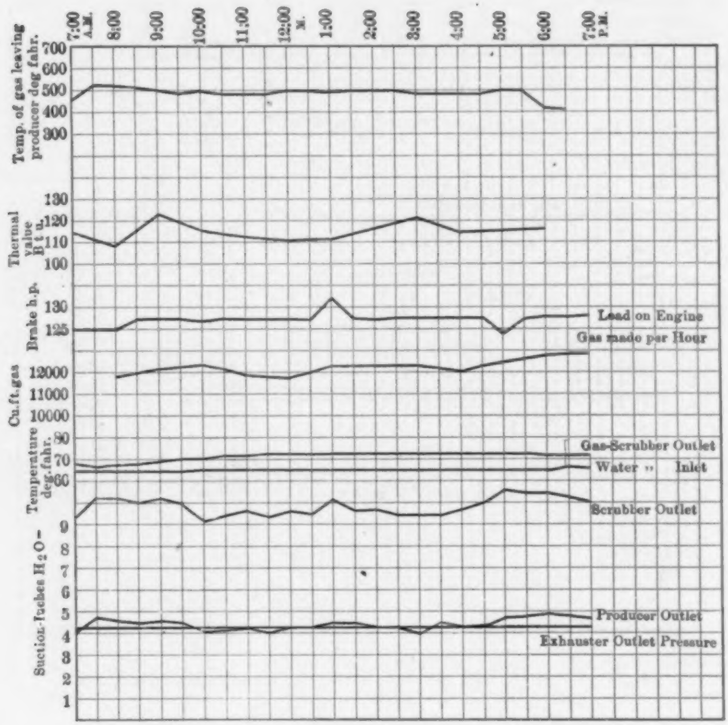


Fig. 6 Log Texas Lignite, End of Test, 114 hrs.

14 Test H, 25 determinations of Pittsburgh run-of-mine, shows well under 0.02 gr. per cu. ft., which is below the usual guarantee. In tests M and N determinations on Texas lignite averaged 0.0193 gr. per cu. ft. These results are borne out by results in the field. Seventy-three determinations at Denver[1] averaged 0.022 gr. per cu. ft. In these tests all of the gas determinations represent average gas drawn continuously throughout the day's run. In no case are

[1] Western Chemical Co

snap samples used. The latter method of testing should be rigorously avoided except for some special purposes, as it affords no indication whatever of average conditions.

15 In former papers[1] the writer has described the method of obtaining producer efficiency from isolated tests. Fig. 3 shows the close agreement of this theory with the fact based upon these several different kinds of coal tested. The interesting point is illustrated, *that the gas producer varied only 10 per cent in efficiency throughout its normal range of load*. This type will give approximately 70 per cent

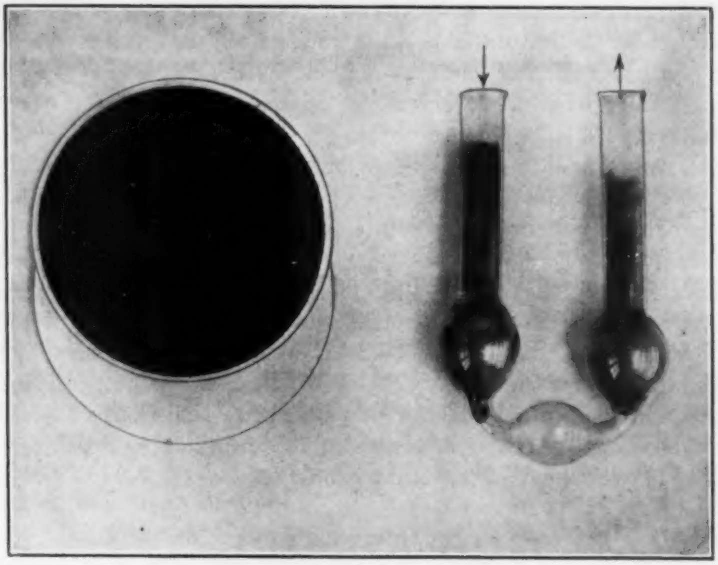


FIG. 7 COMPARATIVE METHODS OF TESTING FOR IMPURITIES

5 CU. FT. EACH 30 MIN.
0.0259 GR. PER CU. FT. FILTER PAPER, TWO LAYERS
0.0216 GR. PER CU. FT. COTTON BATTING, TWO LAYERS

efficiency (on an effective heat basis), or 77½ per cent (total heat basis), at full load. This is manifestly reasonable by inspection of Table 5. That all fuels should fall so closely on the heat input lines at various loads, is a remarkable agreement, and closer than anticipated.

16 However, in a paper by the writer[1] the same agreement was found in plotting the results of tests on another type of plant at Rich-

[1] Norton Test, Vol. 29, Transactions A.S.M.E. 1907; Transactions A.I.E.E., page 1128, vol. 27, 1908

mond, Va. The standby, and three-load determinations, followed almost on a straight line of heat input to producer.

OPERATING RESULTS

17 After the first year's period of tests, this plant was dismantled for examination. The gasification of 182,472 lb. of fuel showed no perceptible effect upon the condition of the producer, the walls being practically intact. This is due to the complete absence of clinkers and high temperatures. Experience plainly shows the latter to be the cause of clinker troubles. The fuel bed normally grades from small ash at the bottom through pure coke to green coal at the top. With proper handling, clinkers may be entirely avoided. For example, Table 9 shows a screen test of coal and ash at the Denver installation—43½ per cent ash through a $\frac{1}{16}$-in. screen.

18 An examination of a long gas main and the engine valves after the year's run, showed no deposits of tar either near or distant from the producer, indicating the complete fixation of the volatiles. All condensibles are removed in a static washer, the cells of which seem to automatically clear themselves of the deposit. For example the pressure drop or resistance through a month's run increased slightly more than ½ in. The principal skill in handling this producer is required in studying the characteristics of various kinds of fuels. Each must be handled differently for best results. With friable fuels the "let well enough alone" rule is particularly desirable, as resistance of the bed may be greatly increased by too much poking.

GENERAL CONCLUSIONS

19 With the writer's good fortune to have obtained directly or to have analyzed results, from several types of producer plants, has come a conviction along certain broad lines on producer practice in general. Knowing the facts regarding daily performance from both shop and field, the statements herein contained are believed to be conservative. The idea is not meant to be conveyed that successful working has been confined to any one particular type of plant or equipment. But those undertakings that have been backed up by experience gained in tests on a commercial scale, are certainly most sure of success and worthy of support. There is much activity resembling plagiarism in the power gas field—guarantees based solely on productions from competitive results, portions of a foreign design

incorporated in an incoherent whole, etc. Such mis-matching inevitably leads to failure without thorough analysis of cause and effect. In short, the great desideratum is a campaign of investigation at the factory—not of the shiftless pounds-and-kilowatt order, but sufficiently comprehensive to facilitate accurate interpretation. Many failures that now lie to the discredit of the internal combustion system would thus have been avoided.

20 It is also patent that personal prejudice seemingly plays a far too important part in dominating the selection of plants, steam as well as gas, and its effect appears not only in the selection but also in the operation of the plant, which often makes it impossible to secure results which under proper conditions would be easily within reach. It is therefore equally as desirable to analyze reports of poor results obtained from a given plant, as of results which seem so good as to arouse suspicions of inaccuracy.

21 Finally—a present need in producer work is some reasonably accurate means of control indicating and compensating for "low gas," which may result from poor condition of fuel bed. Automatic production without the holder storage has now become an accomplished fact with the simplest apparatus, but no means are available for keeping under observation the heat value, except the cumbersome and delicate Junker calorimeters. Were it possible to alter in inverse proportion the ratio of air to gas at the engine accordingly, maximum efficiency could be maintained. But this variable factor has received practically no attention, and as a consequence producer operators are working entirely in the dark.

22 The principle of tar-free gas production has its demonstration in the type of producer under discussion, and it is believed the end justified the means, even at the slight expense of heat value. Due to unknown and complex reactions, tar laden or "green" gas possesses somewhat higher heat value than tar-free gas, due possibly to the preservation of more unstable hydrocarbons. This might then become a factor in rating, with engines designed with little or no margin. But good practice today recognizes no difference between gas of 110 and 125 B.t.u. The margin necessary is present for other reasons, and there is therefore no practical obstacle in the way of development of the tar-free type of gas producer in any form.

23 Further investigations are also urgently needed, as to the possibility of large units. If the gas engine is considered behind the times in the matter of development of large units as compared with steam practice, the producer is hopelessly so. For rapid future delvel-

opment, large units are an obvious necessity. We have steam turbine units capable of sustaining continuous loads of 30,000 h.p., boiler units of 2000 to 3000 h.p., gas producers of only a few hundred, maximum. The very multiplicity of units thereby required in the design of a large station, very seriously militates against the selection of the producer gas system of motive power.

TABLE 3 FUEL DATA

Test	Lbs. charged incl. standby	Lbs. Charged		Lb. per[1] sq. ft. per hr.	Fuel Consumption			
					Per b.h.p. hr.		Per kw. hr.[4]	
		per hr.	max.		Gross[2]	Net[3]	Gross	Net
A	5003	151.6	160.8	15.2	2.3	2.3	3.33	3.33
B	60740	194	228.5	19.4	1.59	....	2.31	
C	53925	181.1	207	18.1	1.14	....	1.66	
D	27157	169.2	222	16.9	1.39	1.19	2.01	1.73
E	35647	184.6	202	18.5	1.24	1.08	1.8	1.56
I	4849	104.2		10.4	1.37	....	2.0	....
J	6065	126.4		12.6	1.25	....	1.81	....
K	6403	133.4		13.3	1.06	....	1.54	....
L	10699	149.1		14.9	.983	....	1.42	....
M	16964	233.1		23.3	1.82	....	2.64	....
N	11503	272.1		27.2	1.80	....	2.61	....
F	8813	14.9			This standby rate applies to previous tests			
G	1680	10.0			Standby rate reduced by reducing updraft on fire			

[1] Based on area at level of green fuel.
[2] Including standby coal.
[3] Standby fuel deducted.
[4] Based on 92.5 per cent generator efficiency.

TABLE 4 GAS DATA

Test	Cu. ft. uncorrected	Cu. ft. per hr. 60 deg. fahr. 30 in. Hg	Max. for 1 hr.	Cu. ft. per lb. fuel	Cu. ft per b.h.p. hr.	B.t.u.* per cu. ft.† total	B.t.u. effective
A	238,900	7245	8500	47.7	102	113.4	
B	3,873,000	12400	16700	63.8	101.4	118.2	
C	4,812,200	16210	23300	89.3	102.1	113.8	
D	2,074,500	15660	21500	88.2	101.9	110.7	
E	2,797,470†	16600	17853	90.2		111	
H		17815	21511	(9 hours)		111.4	
K						119	100.7
L						120.6	112.2
M	891,300	11933		51.3	93.1	118.7	107.8
N	569,300	13092	15500	48.05	86.75	129.7	118.75

* Total heat values. H_2O determination not made during some tests.
† Corrected to 30 in. Hg and 60 deg. fahr.

TABLE 5 PRODUCER EFFICIENCY

Test	Producer Efficiency Based on		Plant Efficiency Based on	
	Total	Effective[1]	Gross Coal	Net Coal
A	76.3	....	.....	.....
B	78.8	....	16.75	.....
C	76.5	....	16.8	.....
D	77.2	....	13.9	16.05
F	75.5	....	15.45	17.6
V	.....	....	13.2	.....
J	.....	....	14.7	.....
K	.....	....	17.5	
L	.....	....	17.7	.....
M	76.8	69.8	17.5	.....
N	76.95	70.2	17.6	.....

[1] Efficiency on effective basis from 7 to 8 per cent lower than on total.

TABLE 6 DUST DETERMINATION

TEST H. PITTSBURGH RUN-OF-MINE

Load h.p.	Gas per hr. cu. ft.	Impurities in Gas, Gr. per Cu. Ft.		
		Average 5 Determinations	Max.	Min.
142	14910	0.02079	0.0432	0.0129
137	14310	0.02087	0.0398	0.0100
170	17740	0.01712	0.0318	0.0062
184	19260	0.01611	0.0287	0.0034
183	19160	0.01718	0.0450	0.0063
204	21511	....	......	......

TEST M. TEXAS LIGNITE

Duration of Tests, hr.	114
Average Load, b.h.p	140
Lignite Fired, lb	28,467
Gas Made, cu. ft.	1,400,000
Average Impurities, gr. per cu. ft.	0.0193
Maximum, gr. per cu. ft.	0.0770
Minimum, gr. per cu. ft.	0.0010

TABLE 7 TYPICAL GAS ANALYSES

Test	Fuel	H_2	CO	CH_4	CO_2	N_2
A	So. American Lignite..............	17.4	10.4	2.4	12.4	56.6
B	Colorado Lignite..................	17.6	11.6	2.6	13.2	54.4
C	Pittsburgh........................	14.1	15.2	1.8	9.6	58.9

TABLE 8 CHARACTERISTICS OF LIGNITE GAS

WESTERN CHEMICAL CO., DENVER

Date	Heat Value (Total)				Impurities			
	No. of Determinations	Max.	Min.	Average	No. of Determination	Max.	Min.	Average
4- 8-09	3	129.6	112.4	123.0	4	0.0290	0.01567	0.0213
4- 9-09	4	121.5	113.7	118.3	.	......	......	......
4-10-09	4	123.9	106.1	113.1	.	......	......	......
4-11-09	.	.....	.....	.....	.	......	......	......
4-12-09	1	.....	.....	122.0	7	0.0617	0.0144	0.0284
4-13-09	2	115.4	111.0	113.2	6	0.0667	0.0081	0.0231
4-14-09	3	124.0	121.0	122.0	7	0.0264	0.0115	0.0184
4-15-09	2	117.3	113.7	115.5	3	0.0204	0.0051	0.0114
4-16-09	3	128.0	114.7	119.5	4	0.0198	0.0048	0.0124
4-17-09	1	.....	.....	133.3	3	0.0260	0.0200	0.0247
4-19-09	4	128.6	108.5	121.2	2	0.0194	0.0058	0.0126
4-20-09	4	128.0	108.5	117.8	3	0.0046	0.0018	0.0033
4-21-09	3	117.8	110.0	114.7	3	0.0095	0.0051	0.0051
4-22-09	3	130.0	111.0	121.0	2	0.0288	0.0113	0.02005
4-23-09	3	129.0	123.4	126.0	3	0.0048	0.0018	0.0033
4-24-09	2	126.0	106.4	115.7	3	0.0064	0.0036	0.0053
4-26-09	1	.....	.....	125.0	.	......	......	......
4-27-09	1	.....	.....	120.4	3	0.0429	0.0040	0.0179
4-28-09	3	141.6	127.0	133.2	3	0.0089	0.0026	0.0056
4-29-09	2	131.0	136.0	128.5	3	0.0099	0.0059	0.0073
4-30-09	.	.....	.....	.....	3	0.0172	0.0066	0.0123
5- 1-09	.	.....	.....	.....	3	0.0356	0.0216	0.0304
5- 2-09	.	.....	.....	.....	2	0.0587	0.0340	0.0463
5- 3-09	.	.....	.....	.....	3	0.0328	0.0067	0.0205
5- 4-09	.	.....	.....	.....	3	0.2325	0.0735	0.1381
Average				121.2				0.02227

TABLE 9 SCREEN TESTS—FUEL AND ASH—NORTHERN COLORADO LIGNITE

WESTERN CHEMICAL CO., DENVER

	Coal	Ash
Over ¼ inch	58 per cent	23.5 per cent
Over $\frac{1}{16}$ inch	23½ per cent	33.0 per cent
Through $\frac{1}{16}$-inch	18½ per cent	43.5 per cent
	100 per cent	100 per cent

Samples represent about one bushel of material quartered down taken from stock pile.

TABLE 10 TYPICAL PRODUCER OPERATION

	Plant A			Plant B		
	Texas Lignite			Pocahontas		
	Max.	Min.	Avg.	Max.	Min.	Avg.
Date of Observation	May 20-29, '08.			Apr. 1-9, '08.		
No. of Determination	20			24		
CO_2	11.6	8.0	10.0	11.6	8.6	9.9
O_2	0.9	4.0	0.63	.....	.....	.....
CO	14.8	12.0	13.7	19.4	11.4	15.7
H_2	19.3	11.84	15.3	12.4	4.7	9.09
CH_4	2.52	1.5	1.88	8.8	5.1	67.6
N	62.4	5.7	55.2	65.1	53.9	5.93
Heat Value Total	109.9	89.2	102.7	166.4	110.4	133.1
Heat Value Effective	.....	....	.....	157.8	101.0	124.5
Fluctuation B.t.u.	.....	....	20.7	.....	.....	56.0
Fluctuation Per Cent = Avg. Value	....	....	10.1	.....	.....	21.0

SYMPOSIUM ON

THE EFFECT OF SUPERHEATED STEAM ON CAST IRON AND STEEL

Three papers: Cast Iron Fittings for Superheated Steam, by Prof. Ira N. Hollis, Boston, Mass; The Effect of Superheated Steam on the Strength of Cast Iron, Gun Iron and Steel, by Prof. Edward F. Miller, Boston, Mass.; Cast Iron Valves and Fittings for Superheated Steam, by Arthur S. Mann, Schenectady, N. Y.

CAST-IRON FITTINGS FOR SUPERHEATED STEAM

By Prof. Ira N. Hollis, Boston, Mass.
Member of the Society

The failure of a number of large cast-iron fittings in use with superheated steam has rightly created a widespread suspicion of this material when exposed to high temperature. Yet on this subject there is very little information of a character to justify the wholesale substitution of steel castings for the ordinary heavy cast-iron fittings. The latter have been used with success for many years at all degrees of temperature below actual redness, and in many stations now in operation with moderate degrees of superheating (say 100 deg. fahr.) cast iron has never given the slightest trouble beyond the ordinary wear and tear.

2 The doubt as to the reliability of cast iron has seemed to spring up with its use in long pipe lines to steam turbines where the temperature has ranged from 550 deg. to 600 deg. This would lead one to ask if the difficulty has not been in the design of the piping systems rather than in the character of the material. Has not the cast iron taken the brunt of a new service and has it not suffered in the estimation of the engineering public because the conditions of that service were not fully understood?

3 A vast amount of experiment and investigation would be required for the satisfactory reply to this question, and this brief paper

is not intended as a reply, but rather to place before the Society a record of some tests that may throw light on the subject. These tests were made for the Edison Illuminating Company of Boston for the purpose of determining the bursting strength under hydraulic pressure of some large fittings which were replaced with steel castings.

4 It may be well before giving the result of the tests to inquire what is actually known about cast iron subjected to high temperature; that is, known without the possibility of controversy:

a Fittings have developed cracks and small changes of shape after a few months of actual service.

b Fittings exposed separately to superheated steam at a temperature exceeding 500 deg. fahr. have shown a permanent increase of some dimensions.

c The tensile tests of pieces cut from fittings that had failed in service indicate in some cases the possibility of permanent loss of strength.

5 The remainder of the evidence in the case may be classed as good guesswork based upon some preconceived theory as to the behavior of the constituent parts of cast iron in a rising temperature.

6 One of the curious and interesting qualities of cast iron is its permanent increase of dimensions under high temperature. This is paralleled by the permanent set of cast-iron test pieces when subject to very moderate tensile stresses. In both cases the cast iron apparently continues to grow at a decreasing rate, at least in some dimensions, when the high temperature or tensile stress is repeated.

7 How long this growth would continue is not known. Its probable limit is the flow of the material under the ultimate breaking stress. Cast iron may not be peculiar in this respect and all materials may change permanently their dimensions under moderate stress, the change growing with each imposition of the same stress. There is no doubt of this where the yield point has been exceeded. It may also be that all materials change permanently under repeated application of high temperature.

8 The cause of the persistent expansion under high temperature is still very hazy, but two possible agencies have been mentioned in a number of discussions:

a A chemical, or physical, change in the relation of the iron to the various foreign substances which fix it as cast iron.

b A molecular change due to the fact that cast iron has no well defined elastic limit or modulus of elasticity.

9 Both causes may be in operation at the same time, but the theory of chemical change has far less standing than that relating to the stresses produced by unequal expansion. While there is a temperature at which carbon changes its relation to the iron, superheated steam is probably well below that point except under very unusual conditions.

10 That cast iron loses strength when exposed to superheated steam at 600 deg. is not conclusively proved. The most that can be said is that test specimens taken out of cast-iron fittings after one year's or more exposure to a temperature of 550 deg. to 600 deg. have shown a surprising irregularity of strength in the same casting. But there is nothing to prove that new cast-iron fittings have not a great lack of homogeneity. Irregularities exist in every casting owing to the inability of the metal to flow when cooling below a certain temperature. Furthermore, the strength of a test piece cast from a given heat can rarely be taken as that of any selected part of the fitting cast from the same heat. It is common experience to find variations of strain in castings as well as variations of texture. Were any large, irregular casting cut into small test pieces, the variations of strength would probably be found to be quite as great as that reported later on in this paper. The demonstration of the loss of strength after long service with superheated steam does not seem either complete or conclusive.

11 A very brief description of the essential features of the Edison station will help to make clear what follows. The new part of the station is arranged in a series of complete units each consisting of one vertical Curtis turbine and eight boilers set in pairs. The main steam line extends along the rear ends of the boilers just beneath the brick work, four eight-inch vertical steam mains connecting each pair of boilers with the main line. Three of the vertical mains discharge through gate valves into T's, and the fourth, at the end of the line, through a gate valve into a bend.

12 The first turbine units were provided throughout with cast-iron fittings, which were ultimately replaced with steel fittings. No expansion or slip joints are used. The main steam line (something over 103 ft. long) is anchored at the turbine end and is allowed to expand freely in a longitudinal or horizontal direction carrying the lower ends of the vertical mains with it. The steam pressure is 175 pounds, the superheating generally amounts to 150 deg. fahr., although it is not constant. The actual temperature of the steam varies from 500 deg. to 580 deg., so that the main line is changing in

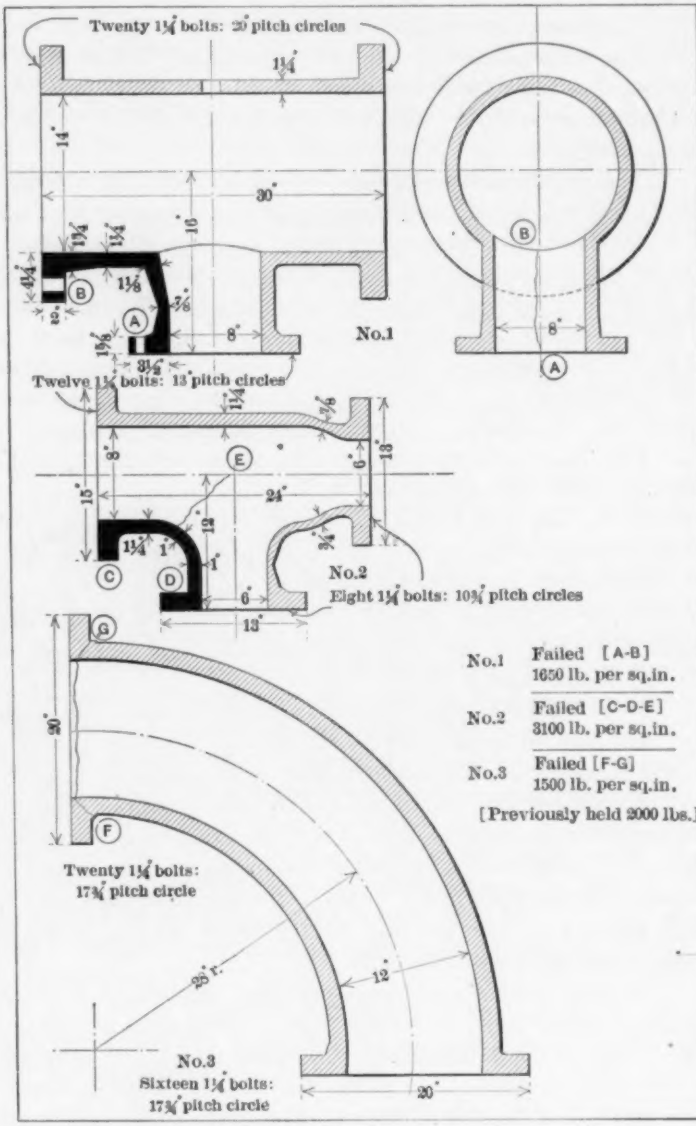


FIG. 1 SHOWING POINTS OF FAILURE UNDER HYDRAULIC PRESSURE OF THREE CAST-IRON FITTINGS USED WITH SUPERHEATED STEAM

length from time to time, thus moving the lower ends of the vertical mains back and forth. A series of variable stresses are consequently introduced into all parts of the pipe system, probably affecting most seriously the T's. It is this aspect of the case, namely, the effect of varying stresses upon cast iron at high temperature, that must be studied before a sound verdict can be reached.

13 The castings in the South Boston station were first suspected of failure when nearly a year after the turbine plant had been in operation one of the 8 in. by 6 in. by 6 in. T's near the boiler showed signs of deterioration, cracks appearing near the junction of the offset with the body of the T and in the flanges. Another fitting of the same dimensions and location began to fail and was taken out after fourteen months' service. Both these T's were cut up for testing and the results were so much alike that only the second is given here as that T had been exposed the longest to the strain.

14 A chemical analysis gave the following: Carbon, 3.47; Manganese, 0.10; Phosphorus, 0.366; Sulphur, 0.062; Silicon, 1.41. The tensile strength of six pieces taken from different parts of the T was found to be, 12646, 14295, 26080, 27270, 27440, 28280 lb. per sq. in. There thus appears to have been considerable variation of strength in the T unless the first two results are errors due to some faults in testing. Not considering them, the four other pieces do not appear to indicate any great falling off in service. They are as near together as would commonly be found in cast iron from the same heat. The material was supposed to be a first-rate quality of air-furnace gun iron which should have been good for 25000 to 30000 lb. per sq. in., but no tests or analyses of the heat from which this T was poured are on record.

15 Four test pieces cut from a larger T, 14 in. by 12 in. by 8 in., which had had about the same service as that from which the foregoing test pieces were cut, gave a tensile strength of 23130, 23480, 23875, 24170 lb. per sq. in. Here again there was absolutely no proof that the material had deteriorated.

16 Three test pieces were taken, for comparison, from a large manifold which had been seven years in service with saturated steam, and the tensile strength was found to be 16413, 16550, 17000 lb. per sq. in. The nature of the cast iron was not known positively, but it was bought as air-furnace gun iron.

17 It was fully recognized in the first of the foregoing tests that, while the material might not have suffered in service, nevertheless parts of the casting might have been weakened by the expansion

stresses. For the purpose of testing this, two T's were removed from the line and broken by internal hydraulic pressure, thus affording a definite idea of the strength of the castings as a whole. A third casting, an L not previously in use, was added for comparison. The three fittings are shown in Fig. 1 in which the measured dimensions and the location of the fractures are given.

18 The material was the same as that used for all the fittings of the turbine unit, air-furnace gun iron, and the chemical constituents were probably about the same. The two T's had been exposed to superheated steam of 578 deg. fahr. and less for fifteen months, or longer, and when removed had given no indications of weakness. A careful examination disclosed no appreciable distortion except in the faces of the flanges which were no longer plane surfaces. There were several high spots that could not have existed when the flanges were faced off.

19 No. 1 was a 14-inch T with an 8-inch offset. The openings were closed by heavy cast-iron plates fitted to the flanges and bolted. The pressure was produced by a steam-driven outside-packed plunger pump, and was measured by means of a small conical safety valve, one-tenth of a square inch in area, and directly loaded by dead weight applied as the pressure increased. The indications of the small valve were constantly compared with a hydraulic gauge previously tested and calibrated at the Crosby manufactory. The fitting broke as shown at an internal pressure of 1650 lb. per sq. in. The plates covering the openings did not reinforce the T to any great extent as the bolts were smaller than the holes and the joints around the flanges were leaking appreciably when the fracture occurred.

20 No. 2 fitting was an 8-in. by 6-in. T. It was broken in precisely the same manner as No. 1 and gave way at an internal pressure of 3100 lb. per sq. in.

21 No. 3 fitting was a 12-inch L. Its two openings were closed with cast-iron plates and it was burst in the same way as the others. The joints practically gave out at a pressure of 2000 lb. per sq. in. although the pressure was kept on for some minutes. For the second attempt to run the pressure up, the bolts were set up with a very heavy wrench, which undoubtedly put a bending moment on the flange. The fitting finally parted all around the root of the flange at a pressure of 1500 lb. per sq. in.

22 Four test pieces were cut from the larger T and broken under tensile stress. Their dimensions were almost exactly $\frac{3}{4}$ in. in diameter by 6 in. between fillets. Two of them were broken cold and

gave a tensile strength of 22150 lb. per sq. in., and two were broken at a temperature of 590 deg. at 20050 lb. per sq. in. The temperature of the latter was maintained by means of a cylinder-oil bath, the oil being placed in a large tube surrounding the test piece and kept hot by a gas flame.

23 No information could be obtained as to the original strength and chemical composition of the iron and it would be impossible to prove that it had changed either in strength or in composition. There is ground, however, for believing that it had changed, as the smaller T mentioned gave as high as 28000 lb. tensile strength in one specimen.

24 A comparison of the larger T with those tested and reported in the Valve World for November, 1907, throws an interesting light on the subject. The formula there published as derived from a very large number of tests of cast-iron and ferro-steel fittings may be taken as a basis for calculating what should have been the bursting pressure of the 14-inch T. This formula is $B = \frac{T}{D} \times S$, where

D = inside diameter of the T
T = thickness
S = tensile strength of the material multiplied by 60 per cent
B = bursting pressure in pounds per square inch.

25 Taking the tensile strength of the cast iron when hot at 20000 lb. per sq. in. the diameter of the T at 14 in. and the thickness at $1\frac{1}{4}$ in. the value of B is 1070 lb. per sq. in. whereas the T actually burst at 1650 lb. This did not seem to indicate weakness or deterioration.

26 It is interesting to inquire here what stress existed in the T during its service. That due to the steam pressure was small when compared with the actual bursting pressure, but that due to expansion may have been serious in its effect. The first T in the main steam line was located at 4 ft. $8\frac{5}{8}$ in. from the anchorage, the second 37 ft. $8\frac{5}{8}$ in., the third 70 ft. $8\frac{5}{8}$ in., and there was no expansion joint to ease off the pressure on the vertical mains. Taking the third T for purposes of illustration, certain suppositions can safely be made:

- *a* The lower flange of the vertical pipe moves in a horizontal plane as the main pipe expands and therefore the lowest point of the axis of the pipe moves parallel to itself.
- *b* The upper end of the vertical pipe is practically fixed. The expansion of the main steam pipe thus puts an S bend in the vertical pipes and introduces large bending movements

into both ends of it and into the T. The actual length of the pipe between its lowest flange and the upper end is 26 ft., but the length between the upper surface of the T and the upper end of the pipe is about 28 ft.

27 The linear expansion of the main steam line is about 3 in. when heated to 578 deg. fahr. The effect of this is supposed to be halved by cutting the pipe short and springing the flanges into place when making the joints. There is thus an initial deflection in the vertical pipe. This is overcome as the pipe is heated and carried as much farther on the other side.

28 The value of the deflection in the lower end of the pipe is then taken at 1.5 in. The formula for the maximum deflection of a beam fixed at one end and moved parallel to itself at the other end is

$$Y = \frac{Wl^3}{12\,EI}$$

W = load in pounds or push of the horizontal pipe.
l = length in inches.
E = modulus of elasticity.
I = moment of inertia of the pipe.

The inside diameter of the pipe is 8 in. and its thickness is 0.322 in. giving the value of $I = 72.5$. E is taken at 30,000,-000.

29 The equation for the deflection is then

$$1.5 = \frac{312^3\,W}{12.725 \times 30{,}000{,}000}$$

and W is found to be 1288 lb. Thus if the expansion of the pipe is exactly split by cutting the main line short, the push on the lower end of the vertical mains is 1288 lb. The point of contrary flexure in the S bend of the pipe is about 179 in. above the junction of the offset of the T with its main body. The bending moment in the offset of the T is therefore 1288 × 179 inch-pounds and the stress set up is

$$S = \frac{Mc}{I} = \frac{1288 \times 179 \times 5}{290} = 3975 \text{ lb.}$$

30 While this calculation is not entirely reliable on account of the uncertainty as to the elastic curve of the vertical pipe, nevertheless it is a fair indication of the stress to be expected in this T when the

temperature of the pipe reaches 578 deg. Furthermore, it is made under the supposition that the expansion of the pipe was lessened by an initial pull and that all the joints came exactly fair before setting up the bolts. It is easy to imagine how serious the stresses might have become under actual conditions of inaccurate fitting. The one element of splitting the expansion is very uncertain. The foregoing stress might easily have been doubled, resulting in pulling the T quite out of shape and in setting up internal strains certain to weaken the material in places.

31 Under such conditions, it was, and would generally be, wise to replace the cast-iron T's with cast steel which would yield more readily to expansion and which would be safer at much higher tensile stresses. The reason for the substitution ought not to be lost sight of in such a case, if cast iron is to be judged fairly. It is made because it is cheaper on the whole to replace the cast iron with steel rather than to put in expansion or slip joints. Perhaps the steel casting is also much easier to take care of than any form of expansion joint. The unreliability of cast iron in such a service has nothing to do with the case: it is merely that the design usually adopted for steam piping does not quite fit cast iron.

THE EFFECT OF SUPERHEATED STEAM ON THE STRENGTH OF CAST IRON, GUN IRON AND STEEL

By Edward F. Miller, Boston, Mass.
Member of the Society

The object of this paper is to describe some experiments made to determine the effect of superheated steam on cast iron, gun iron and steel. From each piece to be tested two tension specimens were made, one to be subjected to the action of superheated steam, and one to be used in obtaining the original strength of the piece.

2 All of the specimens were made with screwed ends in accordance with the specification prepared by the American Society for Testing Materials. The tension tests were made on a 100,000-lb. Olsen testing machine, the specimens being screwed into spherical holders attached to the heads of the testing machine, thus ensuring a straight tension pull without any bending.

3 The specimens to be subjected to superheat were placed on a wire grating suspended at the center of a 12-in. iron pipe about 3 ft. long, supported horizontally on brackets. The ends were closed by blank flanges. Steam was supplied by a small pipe, a flow at low velocity being maintained at all times. The under side of the pipe was heated by Bunsen gas burners. Thermometers, in wells reaching down to the grating on which the specimens were placed, gave the temperature of the steam, the pressure being read from a steam gage on the supply pipe.

4 For the tests plotted in Fig. 1, the average gage pressure in the superheating pipe was 93 lb. and the average temperature 660 deg. fahr. The gas flame was extinguished at 5 p.m. and lighted again at 7 a.m. The temperature reached 660 deg. fahr. by 11 a.m. and by 5 p.m. would be as high as 700 or 720 deg. fahr. Steam was kept in the superheater during the night. The total time these specimens were exposed to superheated steam was 260 hours, and the exposure to saturated steam was 460 hours. A chemical analysis of the iron tested is given in Table 1.

All papers are subject to revision.

TABLE 1 CHEMICAL ANALYSIS OF CAST-IRON SPECIMENS, FIG. 1

	Phosphorus	Total Carbon	Graphitic Carbon	Manganese	Silicon	Sulphur
Cast Iron Gibby Foundry........		3.51	3.02	0.37	1.88	0.05
Gun Iron Hunt Spiller................	0.41	3.25	2.60	0.24	0.54	0.09
Cast Iron Broadway Foundry............		3.34	2.84	0.38	2.26	0.09

5 For the tests plotted in Fig. 2 the average gage pressure was 82 lb. and the average amount of superheat about 390 deg. fahr. These specimens were subjected to superheated steam for 520 hours, and

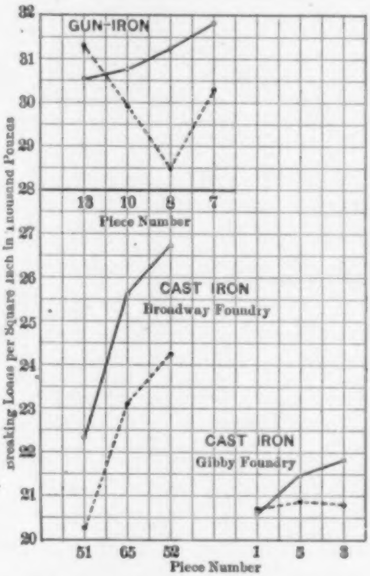


Fig. 1 Breaking Loads of Gun-iron and Cast-iron Test Pieces Subjected to Action of Superheated Steam

to saturated steam for 920 hours. A chemical analysis of three of the semi-steel specimens is given in Table 2. This semi-steel was made by adding 200 lb. of steel to 1500 lb. of cast iron. The analysis of the gun-iron showed, total carbon, 3.37; graphite, 2.44; manganese, 0.34; sulphur, 0.11; silicon, 1.65.

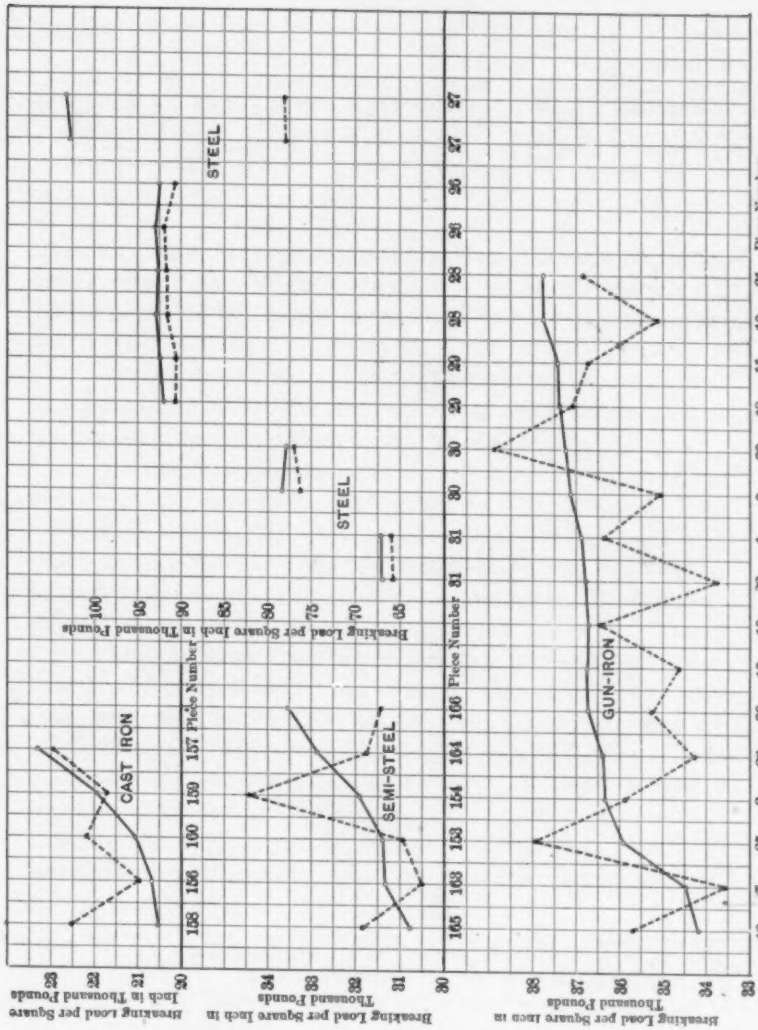


FIG. 2 BREAKING LOADS OF GUN-IRON, SEMI-STEEL AND CAST-IRON TEST PIECES SUBJECTED TO ACTION OF SUPERHEATED STEAM

6 The composition of two of the rolled-steel pieces No. 26 and No. 27 was as follows:

	Phosphorous	Total Carbon	Manganese	Sulphur	Silicon
No. 26	0.85	....	0.73	0.026	0.026
No. 27	0.116	....	0.90	0.057	0.031

7 In Fig. 1 and Fig. 2 the open circles represent the ultimate strength per sq. in. of the original specimen while a full circle on the same ordinate gives the strength per sq. in. of the comparison specimen which had been subjected to the action of superheated steam. By figuring the per cent loss in strength in each specimen and then

TABLE 2 CHEMICAL ANALYSIS OF SEMI-STEEL SPECIMENS, FIG. 2

Phosphorus	Total Carbon	Graphite	Manganese	Sulphur	Silicon
.....	....	2.64	....	0.11	....
0.24	3.48	2.30	0.35	0.11	1.91
0.61	3.22	2.83	0.44	0.49	2.62

taking the average of these per cents it appears that the cast iron from the Broadway Foundry (Fig. 1) lost 9.5 per cent; that of the Gibby Foundry 2.4 per cent. The cast iron of Fig. 2 came from the Waltham Foundry; here there is apparently a gain in strength of 1.8 per cent. Fig. 1 and Fig. 2 show that gun-iron loses strength, Fig. 1 showing a loss of about 3.5 per cent, and Fig. 2 about 2.1 per cent.

8 The tests on semi-steel show an average reduction of strength due to exposure to the steam, of about 0.4 per cent, four out of six pieces showing quite a reduction. If piece No. 154 is not considered, the percentage reduction of strength would be much greater.

9 Four grades of steel were tested; two pieces from a bar of 65,000 to 70,000-lb. tensile strength, two from a bar of 75,000 to 80,000-lb. tensile strength, two each from three bars of about 90,000-lb. tensile strength, and two from a bar of over 100,000-lb. tensile strength. The 65,000 to 70,000-lb. steel showed a loss of 1.8 per cent due to exposure to the steam, the 75,000 to 80,000-lb. steel a loss of 1.9 per cent, the 90,000-lb. steel a loss of 1.5 per cent, and the 100,000-lb. a loss of 24 per cent.

10 While one is not justified in drawing many conclusions from the results of as few tests as are quoted here, still it is evident from Fig. 1 and Fig. 2 that the metals tested have suffered a loss in strength due to their exposure to the steam. A paper bearing on this subject,

Materials for the Control of Superheated Steam, by M. W. Kellogg, appeared in the 1907 Transactions of the Society. In the Valve World, March 1908, are given the results of tests on cast iron taken from the body of a 14-in. valve which had been in use for four years on a main carrying steam at 200 lb. pressure and superheated to a temperature of 590 deg. fahr. A number of test bars cut from the body of the valve showed a loss of strength of 41 per cent when compared with the strength of the original metal as determined from coupons tested at the time the valve was made.

11 Fig. 1 in this paper formed part of the thesis of H. A. Terrill, M. I. T. '07, and Fig. 2 part of the thesis of F. M. Heidelberg, M. I. T. '09.

CAST-IRON VALVES AND FITTINGS FOR SUPERHEATED STEAM

By Arthur S. Mann, Schenectady, N. Y.
Member of the Society

There have been many failures of cast-iron valves and fittings in piping systems carrying steam of high pressure and high superheat. The ordinary extra-heavy flanged cast-iron fittings which are listed in many manufacturers' catalogues as suitable for 200 lb. pressure and which have to meet a close price competition, have successfully carried a pressure perhaps as high as 150 lb. or more. No doubt the fittings and valves can support a steady pressure of 200 lb. without bursting, but there have been many failures when carrying superheated steam of lower pressure.

2 These fittings are not too well suited for permanent work of even 150 lb. pressure, and many engineers in control of such matters in stations of a representative type prefer to design their own parts rather than to trust the usual run of commercial extra-heavy fittings.

3 Probably on account of the advertised ability to support a high steady pressure these extra-heavy fittings and valves have been used in a number of instances for superheated work. After a short time, six months or even less perhaps, cracks make their appearance; valves leak, seats become loose, castings grow in length and surface cracks become so large in size and in number that the casting is removed from the line.

4 A few repetitions of this experience seem to justify the conclusion that cast iron is not fit material for high-temperature steam. The natural substitute is steel, which is used with fair, even complete, success in many cases.

5 It is known that cast iron will grow with repeated heatings and coolings, often observed in the ordinary straight grate bar. When the bar is first heated it expands and cools as it contracts; but if the temperature has been high, the bar will increase in length. With a second heating, a further increase takes place, followed by many others. As a consequence the long single, straight, flat grate

All papers are subject to revision.

warps and proves the wisdom of McClave's rule "Keep your long lines of metal away from the fire."

6 This subject of growth has been treated very completely by Outerbridge in his excellent paper published in the Journal of the Franklin Institute for February 1904. Mr. Outerbridge heated his samples to redness or above, temperatures greatly exceeding that to which a steam-pipe fitting is subjected.

7 A rough experiment on this line was tried by the writer with two samples, one of an ordinary cast iron and a second of a high-grade cast iron, which has proved itself capable of carrying superheated steam and of which a detailed analysis is given in the following pages of this paper. The two samples were each six inches long and one inch in diameter. They were placed in a banked fire over night, reaching a dull red heat, and were allowed to cool in the air. A slight growth as measured by micrometer was found in each piece.

8 This treatment was followed for two or three nights and the growths were measured. There was an increase in the length of each of the samples, the high-grade iron having increased in length slightly more than did the ordinary iron. The experiment so far as it went tended to show that the growth of cast iron does not necessarily unfit it for the usual degree of superheat in power-house work.

9 Many grades of brass will crumble when heated in a forge to a barely visible red, and are quite unfitted to support any stress at such a temperature. But this characteristic in no way unfits very ordinary cast brass for saturated steam work, and one should not hesitate to use a valve of cast brass up to three inches in diameter for 150 lb. saturated steam pressure. Three inches is not usually exceeded because values of large brass bodies are expensive.

10 Articles have appeared in various publications showing the disability of cast iron, tensile tests being made before and after the use of fittings of ordinary iron. Cases of bronze seats dropping from valves were cited and it was not difficult to prove that something better than ordinary cast iron was needed for steam of 180 lb. pressure and 250 deg. superheat. These failures came from two causes. In the first place the iron itself was not of sufficiently good quality; and, secondly, the parts were not thick enough. The static stress probably did not exceed 1000 lb. in the body: but static stress is not the important load which fittings have to support.

11 Stresses from expansion and contraction within and without the casting and stresses from pulling up joints no doubt greatly exceed the static load even in pipe very carefully erected. The troubles are

aggravated by the action of the steam itself, but it is yet to be proved that the steam or its high temperature will of itself start cracks in a properly designed fitting.

12 The ordinary commercial extra-heavy flanged tee, 8 in. inside diameter, has a body $\frac{7}{8}$ in. and flanges $1\frac{5}{8}$ in. thick. It is made of common iron, having a tensile strength of about 18000 lb. Such a fitting will fail with superheated steam at 175 lb. pressure and 200 deg. superheat. Within a year the inner surfaces will have a network of cracks, some of which will increase in depth till they extend through the body. The flanges will crack outward from the bolt holes and the fitting will become not only leaky but dangerous as well. The writer has observed just such castings, an analysis of some of them being given later in this paper. Similar effects have been experienced by a great many steam users. The fittings are inherently weak to begin with, so that the failures do not prove that a heavier fitting of better iron is unsuited for superheated steam work.

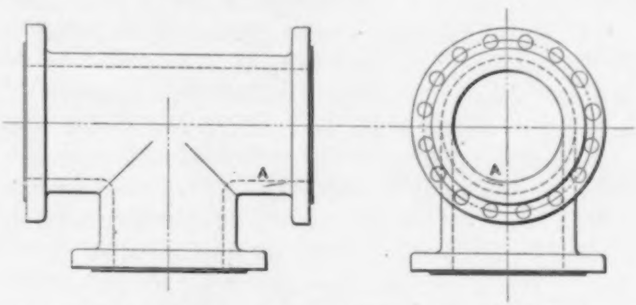


Fig. 1 A 10-in. Steel Fitting, the Irregular Line at *A* Showing Point of Failure under Superheated Steam Service

13 Within the experience of the writer steel fittings have failed with superheated steam. Out of twenty-five steel gate valves, 6, 8 and 10 in. in diameter, not more than four were fairly tight after one year's service, the bodies themselves yielding enough to leak badly. Some defects in the castings developed allowing steam to pass straight through the walls, when they left the foundry. Some of these defects were such that the fittings and valves could not be repaired. In some cases seats were scraped in once or twice and holes were plugged up or patched, but the material would not have been satisfactory without this working over. Yet all these castings were heavy, materially thicker than the commercially extra-heavy cast-iron product, and had passed a rigid inspection.

14 Fig. 1 shows a 10-in. steel fitting; the irregular line at *A* showing a defect developed after use. The line does not pass clear through the casting, and no doubt the piece was amply strong to resist rupture even after the fault developed. Some of these fissures went 3 in. back and were 5 in. broad. Such a large opening in a shell is objectionable for there are blow-holes enough adjacent to it to pass steam in large quantities. Some fittings of this kind were removed from the line entirely, while others were plugged or patched.

15 No doubt a thoroughly sound steel casting is able to withstand highly superheated steam. There are several connected to the system under discussion. So far as it has been possible to observe, superheated steam does not of itself initiate defects and it is not supposed that the sound metal undergoes a change, either chemically or structurally. But if there is an initial defect, superheated steam is much more active in bringing out the objectionable features of that defect. It may well be that the material within the body, and not a part of the actual metal, suffers through change of some sort. This material does not add to the strength of a casting but it may serve to stop up holes if allowed to lie undisturbed.

16 It would appear that some material better than the ordinary steel casting was desirable for high temperature work. Such a material is found in gun iron. Gun iron is nothing more than a high-grade cast iron, which any first-class iron foundry can produce. In the days of the smooth bore cannon, a few foundries discovered that it was possible to produce an iron having a tensile strength of 30,000 lb. or more. The government specified it for its guns and it was called gun iron. Probably a tensile strength of 30,000 lb. is not needed in steam fittings, but iron of that quality is well adapted for 180 lb. steam with 300 deg. superheat.

17 From such observations as have been thus far possible it appears that certain elements in the iron are liable to cause trouble when present in excess, and perhaps the worst of these is silicon. It is at present going too far to say that every high silicon iron will fail and that every low silicon iron will prove successful, but there is much evidence pointing toward the correctness of such a surmise. In any event iron of low silicon, low phosphorus and low carbon—in other words, gun iron—has proved successful.

18 The following analysis shows the character of a casting which failed at 250 deg. superheat:

Silicon	2.40	per cent	Manganese	0.52	per cent
Sulphur	0.067	per cent	Total carbon	3.19	per cent
Phosphorus	0.94	per cent	Combined carbon	0.25	per cent

19 A second failure developed in this iron:

Silicon	1.98	per cent	Manganese	0.42	per cent
Sulphur	0.068	per cent	Total carbon	3.31	per cent
Phosphorus	0.65	per cent	Combined carbon	0.24	per cent

20 In each of these cases a sample was taken by drilling a hole straight into the body after the part had been in service a year or more and was in bad condition.

21 The following analysis is of an iron that has been successful in every respect for four years under 300 deg. superheat:

Silicon	1.72	per cent	Manganese	0.48	per cent
Sulphur	0.085	per cent	Total carbon	2.45	per cent
Phosphorus	0.89	per cent	Combined carbon	0.17	per cent

22 The latter sample is from an 8 in. valve and it is tight today, no repairs whatever having been made upon the valve during the four years though the bonnet was taken off once to permit internal examination. The outer surface of the valve was covered with 85 per cent magnesia insulation, four and one-half inches thick. The inner surface appeared sound; a microscope revealed no cracks or other defects. The unfinished surfaces were struck several sharp blows with a ball-peen hammer, a hand chisel was driven straight at the surface and some thick chips were cut off from the rough portion. If the metal had suffered to such an extent as cast iron is supposed to suffer, some of the defects would have made themselves manifest. After these treatments the valve was reassembled and has continued to perform its work properly.

23 Foundrymen are not afraid to attempt to produce this iron. No difficulty whatever was encountered in securing bids for valves made of the following mixture:

Silicon	1.40 per cent to 1.60 per cent
Phosphorus	0.20 per cent to 0.40 per cent
Sulphur	0.06 per cent to 0.09 per cent
Manganese	0.45 per cent to 0.75 per cent
Total carbon	3.00 to 3.25 per cent

It will be noted that the percentages of silicon and phosphorous are low.

24 There is of course a decided advantage in depending upon chemical analysis for determining the suitability of fittings. A hole can be drilled at any time in the actual fitting and a few grams of

sample secured. Very few of us are willing to destroy a fitting to obtain a test bar, and test coupons cast in the foundry may or may not represent the actual piece.

25 Superheated steam was in commercial use in Europe before the practice had gained its present hold here. England and Germany were using superheated steam twenty or more years ago. The writer has not discussed this subject with engineers from abroad, but wishes to quote briefly those who have.

26 E. D. Dickenson, of Schenectady, on a recent trip abroad asked a great many manufacturers whether they used steel for their superheated work and received a negative reply in each instance. When the manufacturer was questioned in regard to his iron mixture he shrugged his shoulders and replied that he made his iron fit his needs, be it gas-engine cylinder or steam pipe.

27 John Primrose, in Power and the Engineer, for June 8, 1909, states that he discussed the matter with English and German engineers. In one instance a well-known German engineer, who had used superheat for twenty-five years, was surprised that he had not learned of the effect of superheated steam upon cast iron. The engineer promised to investigate the matter in Germany, but he could find nothing to bear out the contention, and could find no one who believed that such a thing was possible.

28 It is not the author's intention to state that steel of good quality will not do for superheated work. Some manufacturers are putting out fittings of open-hearth steel which are doubtless good; but any foundry can make gun iron if it will, and delay and uncertainty will be decreased by its use.

GAS POWER SECTION

REPORT OF PLANT OPERATIONS COMMITTEE

Your Committee has devoted all possible time during the year to executing the instructions of the Gas Power Section and begs to present this report.

2 Briefly, the duties of the Committee, as outlined by the secretary of the Gas Power Section, were to prepare a standard set of forms to be used in connection with the operation of gas power plants, which would show:

- *a* The load curve for various times of the year.
- *b* Cost, character and amount of material used in operating.
- *c* Repair material, cost, etc.
- *d* Operating labor as to the number and character of men, wages, etc.
- *e* Repair labor, cost, etc.
- *f* Detail dimensions of the plant.
- *g* Data on reliability of operation.

3 Taking the requirements of the first six items collectively, as item *g* does not require a special form, your Committee has prepared a set of six forms which are submitted for your approval, as follows:

Form 1 is a Producer Log, for a daily report of the operation of the producer plant.

Form 2 is an Engine Log, for a daily report of the operation of the engine plant.

Form 3 is a Load Curve Form for plotting the load on the station for any desired day.

Form 4 is a Monthly Data Sheet. It is intended for the collection of data obtainable from the daily station records, pay rolls, etc., so as to present a comprehensive monthly statement of the operation of the plant.

Form 5 is a Monthly Cost Sheet. It is intended to show, in a few items, the station costs both of operation and of repairs.

Form 6 is a Dimension Sheet which is self explanatory.

4 All the forms, with the exception of the Monthly Data Sheet, are of the same size as the standard business correspondence sheet, namely, 8½ in. by 11 in.; therefore they may be readily filed in any commercial form of vertical filing cabinet. The requirements of the Monthly Data Sheet are obviously beyond the scope of the standard 8½ in. by 11 in. size. It is therefore made on a sheet just double this size, namely 11 in. by 17 in., so that one fold through the middle of the long way of the sheet reduces it to the standard 8½ in. by 11 in. size, and it may be filed in the same size cabinet. These sizes permit any company having standard letter files to conveniently file, keep and refer to the various forms.

5 Taking up these forms in detail, the Producer Log and Engine Log as submitted provide for a station of not more than three units. This seems to cover the majority of the gas power plants today. Should any company having more than three units desire to use these forms it would be a simple matter to have them reproduced on the 11 in. by 17 in. paper and thereby obtain space for any probable number of units. The Monthly Data Sheet as submitted is also based on a maximum of three units, and here again it would be a very simple matter to provide for additional units by a slight change in the spacing at the top of the sheet.

PRODUCER LOG

6 The Producer Log is intended to be kept by the operator in charge of the producer room. At the left hand side of the sheet is to be recorded the time of starting and stopping each unit and the length of its run, by drawing a vertical line from the time of starting to the time of stopping. The red[1] horizontal lines indicate the time; the longest ones, the hours, the shortest ones, the half-hours, and the others, the quarter-hours. When a producer goes into service, the operator should make a record on the nearest 15-min. line, either by a dot or by a short horizontal line. If the producer is taken out of service again during that day, the same means should be employed to indicate the time. These two dots or short horizontal marks are then to be connected by a vertical line, the length of the vertical line indicating the time the producer is in service. If it should be in service at the beginning of the day and run through into the next, a vertical

[1] Black ink only used in these reproductions. Captions explain colors used in original forms

FORM 1 10-27-'09

THE ____________________________ COMPANY

(City) (State)

Station No. ______

GAS POWER PLANT

PRODUCER LOG

Date ______ 19__

	In Service Producer			Pounds of Fuel Fired Producer			Resistances Inches of Water						Temp. Gas Leaving Prod. Deg. Fahr.		
	No. 1	No. 2	No. 3	No. 1	No. 2	No. 3	No. 1 P.	No. 1 S.	No. 2 P.	No. 2 S.	No. 3 P.	No. 3 S.	No. 1	No. 2	No. 3
P.M. 12															
A.M. 1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
P.M. 1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															

WATER METER

(Readings in cu. ft.)

This reading ________

Last reading ________

Difference ________

GAS MADE

__________ cu. ft.

GAS VALUE (GROSS)

__________ B. t. u.

FUEL VALUE

__________ B. t. u.

Remarks:

______________________ Chief Engineer

See other side

FORM 1, PRODUCER LOG. REPRODUCED QUARTER SIZE (½ WIDTH AND HEIGHT)

THE ACTUAL FORM IS TO BE ON A STANDARD LETTER-SIZE SHEET 8½ BY 11 IN. HORIZONTAL LINES UNDER THE HEADING AND TO THE RIGHT OF THE RECORD OF PRODUCERS IN SERVICE TO BE RULED IN BLUE; OTHER LINES IN RED.

(SEE NEXT PAGE)

(The following note is to be printed on the back of Form 1 of which it forms a part.)

Note: The time in service is to be indicated by a vertical line having its upper end at the time when the producer was started and its lower end at the time when the producer was stopped. The longest horizontal lines indicate the hours and the other lines indicate the quarter-hours. The water-meter should be read at the same time each day.

The gas value given is to be the gross value.
P is abbreviation used for producer.
S is abbreviation used for scrubber.

This log is to be made up at the Station and signed by the Chief Engineer. It must reach the Office not later than noon of the day succeeding that for which the records are made.

FORM 2 10-27-'09 THE__________________________COMPANY

(City) (State)

Station No.______

GAS POWER PLANT

ENGINE LOG Date_________19___

	IN SERVICE ENGINE			INDICATING WATTMETERS			TEMPERATURES, DEG. FAHR.		
	NO. 1	NO. 2	NO. 3	NO. 1	NO. 2	NO. 3	WATER IN	WATER OUT	GAS AT THROT.
P.M. 12									
A.M. 1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12 P.M.									
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									

WATER METER
This reading _____________cu. ft.
Last reading _____________cu. ft.
Difference _____________cu. ft.

SUPPLIES
Cylinder oil_______________gal.
Engine oil_______________gal.
Other lubricants _____________
Waste_________________lb.
Other supplies _______________
____

Remarks:___________________
____
____
____

INTEGRATING WATTMETERS

	NO. 1	NO. 2	NO. 3	AUXIL.
This reading				
Last reading				
Difference				

See other side

____
Chief Engineer

FORM 2, ENGINE LOG. REPRODUCED QUARTER SIZE (½ WIDTH AND HEIGHT)

THE ACTUAL FORM IS TO BE ON A STANDARD LETTER-SIZE SHEET 8½ BY 11 IN. HORIZONTAL LINES UNDER THE HEADING AND TO THE RIGHT OF THE RECORD OF ENGINES IN SERVICE, AND THE CORRESPONDING LINES UNDER "INTEGRATING WATTMETERS," TO BE RULED IN BLUE; OTHER LINES IN RED.

(SEE NEXT PAGE)

(The following note is to be printed on the back of Form 2 of which it forms a part.)

Note: The time in service is to be indicated by a vertical line having its upper end at the time when the engine was started and its lower end at the time when the engine was stopped. The longest horizontal lines indicate the hours and the other lines indicate the quarter-hours. The indicating wattmeters should indicate the *power* being developed by the respective engine units. The integrating wattmeters should give the *work* delivered to the respective circuits. Inlet temperatures will probably be the same for all engines. Outlet temperatures, from all engines, should be read but need only be recorded in rotation. The integrating wattmeters and water-meter should be read at the same time each day.

This log is to be made up at the Station and signed by the Chief Engineer. It must reach the Office not later than noon of the day succeeding that for which the records are made.

line will be drawn from the line marking 12 o'clock midnight at the beginning of the day to 12 o'clock midnight at the end of the day.

7 The next three columns provide for recording hourly the pounds of fuel fired in each producer. Where this is not convenient, and the station is provided with means for keeping the 24-hr. consumption, the total quantity burned for that period can be placed as a footing at the bottom of the column; the hourly record is preferable, however.

8 The next six columns provide for recording hourly the gas pressure in inches of water at each producer and scrubber. The following three columns provide for recording the temperature of the gas leaving each producer. This is something which is not general practice, but your Committee believes the data to be desirable. On the right of the sheet, the amount of water consumed in the producer house is to be recorded. This amount is naturally and readily obtained by a standard form of water meter reading in cubic feet. The water meter should preferably be read at the same time each day; though whatever that hour may be is not material. The reading for the day reported upon is taken from the meter, the reading for the corresponding period for the previous day, or whenever the last reading was taken, is entered underneath, and the difference gives the quantity consumed for the intervening period. Below the water meter records, there is a space for recording the cubic feet of gas made during the day. Your Committee freely admits that it does not know of a meter to be recommended for this purpose, but strongly feels the data to be very desirable, and does know that several manufacturers are endeavoring to develop such a meter. The B.t.u. value of the gas, which follows the quantity record, should be obtained by means of a standard form of gas calorimeter such as is recommended by the American Gas Institute.

9 In this connection, it is desired to point out the fact that gas calorimeters, as ordinarily installed in gas power plants, are practically valueless. The calorimetry of gas is more in the nature of a laboratory operation than a power plant operation, and a gas calorimeter, to do good work, should be installed in a proper location of even temperature and free from dirt and drafts, and should be operated by a man who has been trained for the work, or at least instructed in the refinements of its operation.

10 The B.t.u. value of the fuel burned, which is the last quantity called for on the sheet, should be obtained by means of the ordinary coal calorimeter. Unlike the B.t.u. value of the gas, this need not be determined from day to day. The number and the frequency of the

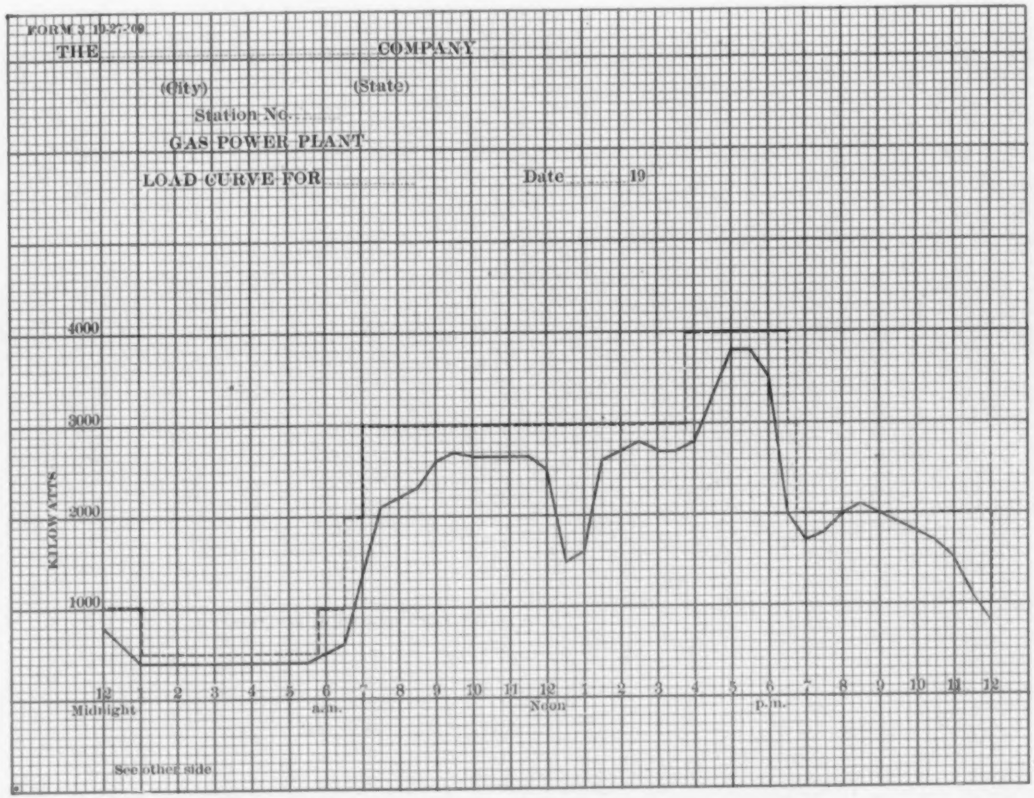
analyses must be determined by each operator, keeping in view the condition of his fuel supply.

11 At the bottom of the form is a space for remarks explaining any departure from the usual routine of operation. The sheet is then to be signed by the chief engineer and sent promptly to the company's office. On the back of the form is a note explaining its use to the station operators.

ENGINE LOG

12 The Engine Log serves a similar purpose for the engine room to what the Producer Log does for the producer room. At the left of the sheet, the run made by each unit is to be recorded in a way similar to the record of the producer units. Following these are three columns calling for hourly readings of the indicating wattmeters of each unit. The next three columns are for recording the temperatures of the cooling water, both entering and leaving the engine. The last column provides for the gas temperature at the throttle of the engine. At the bottom of the form, the readings of the integrating wattmeters of each unit for the 24-hr. period are to be recorded in a way similar to the water meter readings. There is also provision for integrating wattmeter readings covering all the auxiliaries in the station which are operated electrically. This latter quantity is usually small and your Committee does not deem it necessary to attempt to itemize it.

13 At the right of the sheet, space is provided to record the amount of cooling water used in the engine room. Following are spaces for recording the quantities of cylinder oil, engine oil and other lubricants, waste, and other supplies used in the plant. These supplies are intended to include those for the producer room as well as for the engine room. As the bulk of them are used in the engine room, it does not seem worth while to try to divide the amount between the two rooms. Doubtless many operators will find it inconvenient to keep a daily record of these supplies and with many small plants it might not be worth while to attempt such a record; in these cases, the supplies for a longer period of time can be recorded and then transferred to the Monthly Data Sheet. Your Committee, however, recommends a daily accounting where possible. Space is also provided for remarks by station operators, and as in the case of the Producer Log, the blank is then to be signed by the chief engineer and sent to the company's office. On the back are instructions to the operation people on the use of the form.



FORM 3, LOAD CURVE FORM. TO BE $8\frac{1}{2}$ BY 11 IN. RULED IN BLUE

(SEE NEXT PAGE)

(The following note is to be printed on the back of Form 3 of which it forms a part.)

The dotted line shows the rated capacity of the units in service. The full line shows the load as plotted from the readings of the indicating wattmeters.

This curve is to be made up in the Office from data on Station Logs, at such intervals as the Company may determine.

14 In this connection, your Committee wishes to emphasize the fact that meter readings, thermometer readings, etc., are of little value unless accurate apparatus is provided and periodic inspections are made to determine their accuracy. Most of these devices, even with the best of care, will become inaccurate, and all should be checked at frequent intervals by careful men with reliable standards.

LOAD-CURVE FORM

15 The form for the load curve is prepared on standard cross-section paper ruled to tenths of an inch. The vertical scale represents load in kilowatts, its magnitude being determined by the capacity of the station. The horizontal scale represents time, each division indicating fifteen minutes. Your Committee submits a sample Load Curve Form to show how it should be plotted. The solid line is plotted from the readings of the indicating wattmeters as reported on the Engine Log. The dotted line shows the rated capacity of the units in service and is also plotted from the Engine Log. Superimposing these lines shows, at a glance, the character of the load and what units ought to be in operation to meet the demand. Your Committee recommends a load curve of the combined station instead of one for each unit.

16 The load curve may be plotted either in the station or in the office of the company, as may be most convenient. In many cases it will be required only at infrequent intervals, as, for instance, at a factory plant, where the character of the load does not change much from day to day. In the case of electric lighting and railway plants, daily load curves should certainly be made. With the Engine Log accurately filled out and kept on file, it would be a simple matter to make a load curve for any day in the past, if such were required, by referring to the file of station records.

MONTHLY DATA SHEET

17 The Monthly Data Sheet should be made out in the office of the company as early as possible in the next succeeding month. It is a summation of the daily data found on the Producer and Engine Logs, the pay roll of the plant, etc. At the top of the sheet, the normal capacity of the producers, engines and generators is to be filled in, and as these figures will be repeated from month to month, they will naturally be printed with the form when a company is ordering a supply

of blanks. Then comes a brief statement of the kind and size of coal used and the locality of the mine from which it is obtained. For the Class of Service, the work of the plant should be described, as electric-light plant, railway plant, factory, industrial plant or otherwise. A statement of the number of watches or shifts that a plant operates per day and the length of each shift in hours is then asked for.

18 Under the heading Producer Data, at the left of the sheet, column 1 calls for the total horsepower-hours of producers in service for each day of the month; column 2, the daily consumption of fuel in the producer house; column 3, the heat value of the fuel. If the latter is not changing, it is obviously unnecessary to fill this in daily. Column 4 is a summation of the water used in the producer house as measured by a commercial form of water meter.

19 Under Engine Data, column 5 calls for the total horsepower-hours of the prime movers in service during each 24 hours. Column 6 calls for the gas consumed, in cubic feet. As stated in the remarks on the Producer Log, it may be impossible for some plants to fill in this column at the present time. Column 7 calls for the calorific value of the gas. It will be noted that on both the Producer Log and the Monthly Data Sheet, your Committee specifies that this is to be the gross value. The gross value is used in these forms because the American Gas Institute has officially adopted it for use in all cases. It is realized, however, that it is still an open question whether a power plant should use the gross or the net heat value of the gas. It may be an injustice to charge the engines with something they are unable to use. Your Committee, therefore, suggests that this question be referred to the Gas Power Standardization Committee of the Society, and that the latter's opinion be obtained before these forms are formally adopted. Columns 9, 10, 11, 12, 13 and 14 are summations from the Engine Log.

20 Under the heading Load, column 15 calls for kilowatt-hours generated. This is to be interpreted to mean the gross kilowatt-hours delivered by the generators to the station bus bars as indicated by the recording wattmeters for the period, without any deductions being made for current used for station auxiliaries, lighting, etc. In column 16 is to be recorded the maximum load in kilowatts as shown by the hourly readings of the indicating wattmeters. In column 17 is to be recorded the power required by the electrical auxiliaries of the station as shown by their recording wattmeters. Two spare columns are left on the right-hand side of the sheet for data which may be required in special cases.

FOLDER No. 1

FORM 4. 10-27-'09

THE.............................COMPANY

(City) (State)

Station No....

GAS POWER PLANT

DATA SHEET FOR MONTH OF............19..

UNITS INSTALLED:

Gas Producer (No.1--h.p. normal capacity (No.2--h.p. normal capacity (No.3--h.p. normal capacity

Engine (No.1--h.p. normal capacity (No.2--h.p. normal capacity (No.3--h.p. normal capacity

Generators (No.1--kw. normal capacity (No.2--kw. normal capacity (No.3--kw. normal capacity

Kind and size of coal used..............................

Locality of mine..............................

Class of service.............. No.of watches.............. Hours per watch..............

	PRODUCER DATA				ENGINE DATA										LOAD			MISC.	
DATE	H.P. HOURS IN SERVICE	FUEL IN LBS.	B.T.U. PER LB. OF COAL	PRO. WATER USED (CU. FT.)	H.P. HOURS IN SERVICE	GAS USED (CU. FT.)	B.T.U. OF GAS (GROSS VALUE)	TEMP. OF GAS AT THROTTLE (AVG.) DEGREES FAHR.	COOLING WATER USED ON ENG. (CU. FT.)	INLET TEMP. ENG. WATER (AVG.) DEGREES FAHR.	OUTLET TEMP. ENG. WATER (AVG.) DEGREES FAHR.	CYL. OIL (GALS.)	ENG. OIL (GALS.)	OTHER LUBS. (GALS. (LBS.	KW. HRS. GENERATED	MAX. LOAD IN KW.	KW. HRS. OF AUXILIARIES		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
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LABOR:

	Chief Engineer	--hrs. per day	Rate per hour per man	$.
--	Producer men	-- " " "	" " " " "	$.
--	Coal and ash handlers	-- " " "	" " " " "	$.
--	Asst. Engineers	-- " " "	" " " " "	$.
--	Oilers	-- " " "	" " " " "	$.
--	Cleaners	-- " " "	" " " " "	$.
--	Laborers	-- " " "	" " " " "	$.
--	Repair men	-- " " "	" " " " "	$.
--	Electrical operators	-- " " "	" " " " "	$.

REMARKS:

See other side

FORM 4 MONTHLY DATA SHEET. REPRODUCED QUARTER SIZE (½ WIDTH AND HEIGHT)

THE ACTUAL FORM IS TO BE ON A SHEET 11 BY 17 IN. RULED IN RED WITH THE EXCEPTION OF THE HORIZONTAL LINES DIVIDING THE COLUMNS INTO DAYS. THE FOLLOWING NOTE IS TO BE PRINTED ON THE BACK OF THE SHEET:

Note: This form is to be filled out in the Office monthly from information contained in the daily Station Logs, Payroll, etc.

FORM 5 10-27-'09

THE .... COMPANY
(City) (State)
Station No.————
GAS POWER PLANT
COST SHEET FOR MONTH OF 19

OPERATION

SUPPLIES:
Fuel 000 tons @ $000.00 per ton of 2000 lb. (delivered alongside of producer and including disposal of ashes after removal from producer) .... $
Water......cu. ft. @ 00 cents per M cu. ft. .... $

Lubricants: Cylinder oil @ 00 cents per gal .... $
Lubricants: Engine oil @ 00 cents per gal .... $
Lubricants: Other lubricants .... $
Waste and Miscellaneous Supplies .... $

LABOR:
Producer room .... $
Engine room .... $
Electrical .... $
....
....
TOTAL OPERATION .... $

*REPAIRS

LABOR AND MATERIAL:
Producers .... $
Producer room auxiliaries .... $
Main engines .... $
Engine room auxiliaries .... $
*Electrical Equipment .... $
....
....
TOTAL REPAIRS .... $

SUMMARY:
Total Operation .... $
" Repairs .... $
TOTAL STATION COSTS .... $

TOTAL KW. HRS.
Kw. Hrs. generated ....
" " used in plant......
Net Kw. Hrs. output.......COST PER NET KW. HR. .... $

* See other side.

FORM 5, MONTHLY COST SHEET. TO BE PRINTED ON SHEETS 8½ BY 11 IN.

(The following note is to be printed on the back of Form 5 of which it forms a part.)

Note: The entire cost of maintaining a plant should be separated into the cost of *repairs* and the cost of *replacements* and these headings should refer to *units of equipment* and not to *parts* of units. "Repairs" should include the renewals of such parts as grate bars, producer linings, piston rings, pistons, cylinders, valves, springs, igniter plugs, generator coils, armatures, etc. "Replacements" should include the replacement of old producers, engines, generators, etc., with new producers, engines, generators, etc., when the former are worn out or have become antiquated. "Replacements," in so far as their cost equals the original cost, should be paid for out of the depreciation fund. In so far as their cost exceeds the original cost, they should be paid for out of capital.

The cost of repairs to generators, exciters, switchboard apparatus, etc., should be entered under the sub-heading "electrical equipment." The cost of repairs to electrical auxiliaries such as motor-driven fans, motor-driven pumps, ignition outfits, etc., should be entered under the sub-heading "producer room auxiliaries" or "engine room auxiliaries" as the case may be.

This form is to be filled out in the Office monthly from information contained in the daily station Logs, Pay-roll, etc.

21 At the foot of the Monthly Data Sheet is a brief statement of the labor used in the plant. This is not intended to be a summation of the pay roll. It should show the total number of employees of each class, the number of hours constituting a day's work for each class, and the rate per hour paid to each class. In other words, this labor statement is intended to give an idea of the amount and quality of labor required in the plant and can be readily obtained from the station pay rolls. Following the labor statement, a space is left for general remarks. On the back of this form is a brief note explaining how it is to be used.

MONTHLY COST SHEET

22 The Monthly Cost Sheet is a financial summation of the operation of the plant. This is likewise to be filled out at the office of the company. The information is to be obtained from the Monthly Data Sheet, the pay rolls and the records of materials used during the month. Under the head of Operation, the first item calls for the number of tons of fuel, price per ton and total cost of fuel used per month. It will be noted that the word "fuel" is used in its broad sense, and the cost of fuel includes the disposal and removal of ashes. Some members have thought that the disposal of ashes should be a separate item. The opinion of the majority of the members of your Committee is that if the cost of fuel is to be analyzed, the cost of the disposal of ashes is one of the subdivisions, but that it is of no more importance than the freight on the fuel or the cost of handling the fuel, and it is believed that for the present at least it is not worth while attempting to itemize it. The water, lubricants, waste and miscellaneous supplies are all obtained from the Monthly Data Sheet and from the records of materials used during the month. Labor is obtained from the station pay rolls. The summation of the items under the head of Operation gives the total operating cost of the station for the month. Under the head of Repairs, quantities are likewise obtained from the Monthly Data Sheet, the pay rolls and the records of materials used during the month.

23 There has been some discussion about the item headed Repairs for Electrical Equipment. As the form is submitted this item includes all repairs to electrical equipment in the station, whether to main generators, electrical auxiliaries or switchboard apparatus. Your Committee believes that in the average small station it is not worth while to subdivide this item. In large stations it is desirable

so to do, and for such cases blank lines are left for subdivisions. The total of the items under Repairs covers the cost of up-keep for the month, which, added to the operating total, gives the total monthly cost of the station. Following this is a summation of the output of the station. The kilowatt-hours generated and those used in the plant are both obtained from the Monthly Data Sheet, their difference being the net output, which, divided into the total station cost, gives the cost per net kilowatt-hour for the month.

24 Your Committee wishes to call your attention to the note on the back of the Monthly Cost Sheet explaining just what it is desired to include under the heading Repairs. Many companies are not particular about separating the item of repairs from that of replacement; consequently repair data are misleading and often of little value.

25 As this Committee is a plant operations committee it has endeavored to eliminate entirely everything not strictly operating. Some members have criticised the Cost Sheet because it did not include managerial expense, taxes, repairs to buildings and other items of this character. Your Committee feels that these belong properly to the subject of financial expense rather than operating. It is true, for instance, that a power plant must be housed and that it should be charged with the cost of building. The character of the buildings, however, varies so widely, and the cost of the real estate upon which they are built is so much a question of location rather than of the design and operation of the plant, that comparison of these figures means nothing without a knowledge of many details concerning them. Your Committee therefore feels it is wise, at this time, to omit such items.

26 Since these forms were virtually completed, Mr. Davidson of this Committee was fortunately enabled to discuss the proposed Cost Sheet at length, with Mr. Duffy, comptroller of his company, the Milwaukee Electric Railway and Light Company, and with Mr. Hagenah of the Wisconsin Railroad Commission. These gentlemen have kindly given much thought to the proposed forms and have made a number of radical suggestions. Time did not permit your Committee to make full use of these suggestions, but as they are based on wide experience (the Wisconsin Railroad Commission in particular having done a great deal of work on the subject of accounting for public utilities companies) it seems that some consideration should be given to their suggestions. The forms proposed by these gentlemen, together with an abstract of a letter from Mr. Hagenah giving

FORM 6 10-27-09

THE ....COMPANY

(CITY) (STATE)

STATION NO. ....

GAS POWER PLANT

DETAILS OF PLANT

PRODUCERS:

Number..........................Suction or pressure..................

Inside diameter..................Type of bottom....................

Height of fire-bed................Thickness of lining................

Wet Scrubber; type...............Size..............................

Dry Scrubber; type...............Size ....

Vaporizer; type...

GAS ENGINES:

Number..........................Horizontal or vertical.............

R. p. m.........................Single or double acting............

Type of cycle....................How connected to load...........

Cylinders; number................Arrangement......................

Diameter and stroke of pistons......................................

Compression (by indicator) ....Clearance (% of displacement).....

Number of bearings rigidly in line...................................

How started......................Air pressure......................

Type of ignition..................Source of ignition supply..........

AUXILIARIES...

....

....

REMARKS...

....

....

FORM 6, DIMENSION BLANK. TO BE PRINTED ON SHEETS $8\frac{1}{2}$ BY 11 IN.

his arguments in support of the forms they recommend, are therefore contained in Addendum A to this report.

27 About the same time, Mr. Freyn of this Committee called attention to the fact that the forms as proposed did not conveniently meet the blast-furnace gas plant requirements, which is perfectly true. Your Committee had considered that blast furnace gas plants are in a class by themselves, requiring quite different treatment. Most of these plants are adjuncts of large manufacturing corporations which now have their own forms and records. Mr. Freyn, however, was appointed special subcommittee of one to submit forms for blast-furnace gas plants and has submitted forms which also were received too late for your Committee to give them careful attention. They are submitted as Addendum B to this report.

CONCLUSION

28 Your Committee realizes that, in attempting this work, it is trying to accomplish something that has never before been done, namely, to prepare a set of forms to be adopted and used generally by people many of whom are operating gas power plants, not as their principal business, but as a small and necessary adjunct. It is felt that, at least for the present, these forms should be simple, concise, easily kept and so designed that when they are properly kept, they will be of value to the people keeping them. Many operators today keep no records, and if they were approached with an elaborate set of forms each containing many items, they would doubtless refuse to use them on the ground that the expense and inconvenience involved is not warranted by any possible saving. To meët this situation, it has been the intention to err, if at all, in the direction of simplicity. If a set of forms can be prepared which will meet the approval of a large number of power plant operators and be adopted by them, a big step will have been made. The use of these forms for a short time, by a number of concerns of varied character and interest, will quickly demonstrate where they should be altered. It does not at all follow that these forms cannot, in many instances, be elaborated upon at the start, and should a particular operator find that certain items of which he desires to keep a record are not mentioned, it is a simple matter to add such items to the forms submitted.

29 Referring to the forms in Addendum A submitted by Messrs. Davidson, Duffy and Hagenah, your Committee feels that they are itemized more than is necessary for the present, and generally do not

fit the requirements of the work as well as those contained in the report itself. It might possibly be well to give more time to these forms, conferring with the Wisconsin Railroad Commission and other State commissions having jurisdiction over similar accounts in their respective commonwealths, before these forms are finally adopted. It should be borne in mind, however, that a State commission has certain authority regarding what data should be kept and how, while your Committee possesses no such authority and its forms must have sufficient merit to win their own way. Your Committee would also like to point out the fact that a committee consisting of twenty members scattered over a wide range of territory is very unwieldy, especially in work of this character which does not permit of subdivision. Should it be desired to continue the committee it is believed that the work would be greatly facilitated by radically reducing the number of members.

Respectfully submitted

I. E. Moultrop, *Chairman*

J. D. Andrew	J. L. Lyon	*Plant Operations Committee*
W. H. Blauvelt	V. E. McMullen	
V. Z. Caraçristi	V. T. Macleod	
E. P. Coleman	C. H. Parker	
C. J. Davidson	J. P. Sparrow	
W. T. Donnelly	A. B. Steen	
H. J. K. Freyn	F. W. Walker	
N. T. Harrington	C. W. Whiting	
J. B. Klumpp	Paul Winsor	
G. L. Knight	T. H. Yawger	

ADDENDUM A

MONTHLY COST SHEET FORMS

SUBMITTED BY MESSRS. DAVIDSON, DUFFY AND HAGENAH

These forms are submitted by the above named gentlemen as in their opinion superior to those offered by your Committee. They are probably best explained by quoting direct from Mr. Hagenah who writes in regard to them as follows:

After studying the form it appeared to me that while it contained some excellent features in the separation of expenses between Operation and Repairs and these in turn subdivided between Supplies and Labor, my first criticism would be that the blank does not go far enough in the application of these principles. If the object of this blank is to show the cost of electric energy generated by gas power, it should also show, in so far as this is possible, the cost of all elements entering into such final figures. Of primary importance among these items is the cost of power gas. This expense is likewise divisible into the expense of Operation and the expense of Maintenance and these in turn consist of Labor and Supplies.

I have always maintained that the principle of cost accounting, showing the cost of each process in the chronological and natural order of production, should be adhered to wherever possible and departed from only for good reasons. It appears to me that every station engineer would wish to know for his own guidance and satisfaction the cost of so large an item of expense as the gas produced for power purposes. More particularly is this desirable in the case of those plants in which the total amount of gas produced is not used for electric generation, but is produced for the benefit of two or more departments. The blank which you have submitted to me does not admit of this separation and analysis, and since nearly every account contains some gas production expense and some electric power expense, I am inclined to believe the blank would not lend itself to the satisfactory use of some of the larger plants in this state.

In this connection I recall several conferences which were had prior to the final adoption of the present Wisconsin uniform classifications of accounts for the different utility services. When I say that these conferences were attended by engineering and accounting representatives of some of the largest gas and electric plants in the United States, and that this method of separation of accounts received the most thorough discussion and was finally agreed to by them and incorporated in the Wisconsin official classifications, I may be pardoned for submitting the enclosed blanks which recognize the above features and therein go further than the blanks prepared by the Plant Operations Committee.

In defense of the enclosed blanks I beg to call your attention to the fact that they permit of the separate cost analysis; apply equally to plants whose total gas production is used for electric generation or apportioned over several departments; and constitute an elastic outline which can be followed by plants of all sizes. The smaller plants may combine the details of Labor, Supplies and Maintenance into but three accounts, if necessary, while the larger plants can subdivide the accounts given to the greatest degree of refinement without destroying the

basis for comparative statistical study? In regard to the definitions of terms used in these forms and the text of instructions therefor, together with the apportionment of the final cost of production, I beg to refer you to the text of instructions accompanying the Wisconsin classification of accounts for electric utilities, to which classification these blanks conform with the exception of several account titles and subdivisions, in which respect I believe the outline of the Plant Operations Committee is preferable.

The following are some changes which I wish to call to your attention:

The outline of the Plant Operations Committee makes no mention of the cost of removing residuals from buildings. I presume the text of instructions for the blank would cover this point. I prefer the account title Lubricants to Oil in view of the fact that Lubricants is a broader term and I am informed that other lubricants than the two kinds of oil mentioned may be used. This, however, may not be very important. In a large plant I believe it would be advisable to determine separately Maintenance of Generators as distinct from Maintenance of other Electrical Equipment. Small plants could easily combine these two if necessary. The account Removal of Ashes is an improvement over the Wisconsin system. I have added the accounts Maintenance of Producer Buildings, Fixtures and Grounds, Maintenance of Power Plant Buildings, Fixtures and Grounds, for which no provision is made in the outline of the Plant Operations Committee.

The recommended forms follow on the two succeeding pages.

FORM 1 ADDENDUM A

....COMPANY

CITY..STATE....................

GAS PLANT MONTHLY COST SHEET FOR............,19............PLANT NO.....

PRODUCER PLANT AND BY-PRODUCT PLANT

	Amount	Cents per M. Cu. Ft. Gas Produced
Gas and By-Product Production-Operation:		
1 Producer-Plant Operating Labor (Including Superintendence, Fuel Handlers, Producer Plant Labor, Ash Handlers, Miscellaneous Labor, Pumpmen, Water Purification Labor)		
2 By-Product Plant Operating Labor (Including Superintendence, Residual Handlers, Miscellaneous Labor)		
*3 Fuel (Average B.t.u. For one cent............)		
**4 Water (..........cents per M cubic feet)		
5 Removal of Ashes Expense (Haulage; Debit in black, Credit in red)		
6 Producer Plant, Miscellaneous Supplies and Expenses		
7 By-Product Plant, Miscellaneous Supplies and Expenses		
Total Operation		
Gas and By-Products Production-Maintenance:		
8 Producers and Producer Auxiliary Equipment		
9 By-Product Plant Equipment		
10 Coal and Ash-Handling Equipment		
11 Producer Plant Buildings, Fixtures and Grounds		
12 By-Product Plant Buildings, Fixtures and Grounds		
Total Maintenance		
Total Cost of Gas and By-Product Production		
Value of Residuals and By-Products		
Cost of Gas Production (..........cu. ft.)		
***Distribution of Gas Production:		
Electric Generation		
Sales		
Other Purposes		

* Define kind of fuel used, whether coal, coke, lignite, peat wood, or oil, giving unit cost of same to be expressed in Average B.t.u. for one cent. The cost of Fuel to cover cost in storage, including delivery to place of storage; also Fuel Stock Expense, cost of weighing, unloading and handling fuel for storage, covering unloading of fuel from cars, boats or wagons, including cost of the operation and maintenance of scales, hoisting apparatus, cost of shovels or other hand-tools used in the work. Fuel Stock Expense should be closed into Fuel Stock Account.

** Water should be clearly defined as to whether it is the cost of water purchased, the expense of pumping water (to include the cost of the operation and maintenance of the pumps and pumping equipment), or the expense of purifying water (to include the cost of operation and maintenance of the water purification equipment), or all of these. The unit cost of the water used should be expressed in cents per M cubic feet.

*** If the gas produced is used for more than one purpose, for example, for Electric Generation, Sales, or Other Purposes, in the case of a company which makes such uses of its product, the Gas Production should be apportioned to Electric Generation, Sales, or Other Purposes, in the proportion of the use of same for each of the purposes respectively.

Note:—If Fuel Stock Expense, Expense of Pumping Water, or Expense of Purifying Water, as defined above, cannot be ascertained or determined, or if the amounts involved do not justify the use of the accounts Fuel Stock Expense, Expense of Pumping Water, or Expense of Purifying Water, then such accounts are not to be used and the expenses chargeable to said accounts

should be included in such other accounts as the nature of the expenses would properly determine, presumably in account No. 1, Producer-Plant Operating Labor, account No. 6, Producer Plant Miscellaneous Supplies and Expenses, account No. 8, Maintenance of Producers and Producer Auxiliary Equipment, account No. 11, Maintenance of Producer Plant Buildings, Fixtures and Grounds, or account No. 12, Maintenance of By-Product Plant Buildings, Fixtures, Grounds.

FORM 2 ADDENDUM A

....COMPANY

CITY....................................STATE..............

GAS POWER PLANT MONTHLY COST SHEET FOR.........19......PLANT NO.......

PRIME MOVER PLANT

	Amount	Cents per S. B. Kw-Hr. Output
Electric Generation-Operation:		
1 Prime Mover Plant Operating Labor (Including Superintendence, Prime Mover Labor, Electrical Labor, Miscellaneous Labor)		
2 Power Gas Produced (See Producer Plant Sheet for Details)		
3 Power Gas Purchased (........cu. ft. at $........ per M)		
*4 Water for Cooling Engines		
5 Lubricants (Cylinder Oil......cents per gal., Engine Oil......cents cents per gal., Other Lubricants......cents per lb.)		
6 Miscellaneous Supplies and Expenses		
Total Operation		
Electrical Generation-Maintenance:		
7 Prime Movers (Engines, Turbines, other Prime Movers)		
8 Prime Mover Auxiliary Equipment		
9 Generators and Auxiliary Generating Equipment		
10 Miscellaneous Prime Mover Plant Electrical Equipment (Switchboards and Equipment Cables, Feeder Terminals, Wiring other than for buildings chargeable to account No. 11, Miscellaneous Electrical Equipment other than covered in account No. 9)		
11 Prime Mover Plant Buildings, Fixtures and Grounds		
Total Maintenance		
Total Electric Generation:		
Kilowatt-Hours Generated		
Kilowatt-Hours Used in Plant		
Kilowatt-Hour Output at Switchboard		
** Distribution of Kilowatt-Hour Output:		
Electric Railway System		
Electric Light and Power System		
Other Purposes		

* Water should be clearly defined as to whether it is the cost of water purchased, the expense of pumping water (to include the cost of the operation and maintenance of the pumps and pumping equipment), or the expense of purifying water (to include the cost of operation and maintenance of the water purification equipment), or all of these. The unit cost of the water used should be expressed in cents per M cubic feet.

Water used for other purposes than Water for Cooling Engines should be charged to account No. 6, Miscellaneous Supplies and Expenses.

** If the electrical energy generated is used for more than one purpose, for example, for an Electric Railway System, an Electric Light and Power System, or for Other Purposes, in the case of a company operating such a diversified system, the electrical energy should be apportioned

to The Electric Railway System, The Electric Light and Power System, or Other Purposes, in the proportion of the use of same by each of the systems respectively.

Note:—If Expense of Pumping Water or Expense of Purifying Water, as defined above, cannot be ascertained or determined, or if the amounts involved do not justify the use of the accounts, Expense of Pumping Water or Expense of Purifying Water, then such accounts are not to be used and the expenses chargeable to said accounts should be included in such other accounts as the nature of the expenses would properly determine, presumably in account No. 1, Prime Mover Plant Operating Labor, account No. 6, Miscellaneous Supplies and Expenses, Account No. 8, Maintenance of Prime Mover Auxiliary Equipment.

ADDENDUM B

FORMS FOR BLAST-FURNACE GAS POWER PLANTS

Submitted by Mr. Freyn

The following forms which have been submitted to the Committee by Mr. H. J. K. Freyn show his proposed modifications to make the forms suit blast-furnace gas plant conditions. Before these forms are adopted they should, of course, be made on the standard-size sheets recommended in the body of the report. A few suggestions made by Mr. Freyn about his proposed forms are contained in the following extract from his letter to the Chairman of the Committee:

Please note additions made on cost sheet for month, pertaining to cost per kilowatt-hour of various items.

The sheet headed Gas Power Plant covers the gas washing machinery, and number of washers in service, both primary and secondary systems; and gives additional columns of valuable information, such as temperatures, power and water consumption, etc.

The other sheet, headed Gas Power Plant, gives the Gas Engine log, which, of course, is identically the same as for a producer power plant, while it would be advisable to add something as to the cause of shutdowns.

One sheet I added covering the daily chemical report, such as is being kept at this plant, which I find to be of great value.

The data sheet for the month is merely an adaptation for a blast-furnace gas power plant.

The load-sheet curve should preferably be a daily instead of an hourly curve for large power plants in steel works, because the load conditions do not change as radically as in smaller gas power plants.

I do not think that a big power plant can be induced to get up hourly load curves for each day.

One thing that would probably be very desirable is to get up curves showing some of the information given on the data sheet for the month. As a matter of fact the plotting of this and similar information I have found to be very much better and clearer than a compilation of figures. The curve will naturally show any changes in conditions mnch better than the mere figures.

2 Considering the forms in detail, the Gas Cleaning Plant Daily Log serves a similar purpose to the Producer Log of the producer

plant. The Daily Chemical Report is an entirely new form which is justified by the possibility of large variation in the quality of gas and the amount of dust and moisture contained therein. The Engine Log requires no change, consequently the form in the body of the report is applicable in both cases. The space for remarks on the Gas Engine Log is intended to include such information as Mr. Freyn mentions in his letter. The Load Curve Form submitted in the report is obviously perfectly well adapted for the blast-furnace gas plant and is eliminated from the following set of forms. If a load curve for a longer period than twenty-four hours is desired, the form submitted in the body of the report can be used by merely changing the magnitude of the horizontal scale. The Monthly Data Sheet is practically the same as that for a producer plant with the exception that the first few columns are changed to record the daily data from the washing plant. The Monthly Cost Sheet likewise contains very little change from the same sheet of the producer plant, the main items in both cases being the same. The forms are given on the succeeding pages and accompanying folder.

FORM 1 ADDENDA B 10-27-'09

_________________ WORKS _______________ COMPANY

GAS POWER PLANT

GAS-CLEANING PLANT—DAILY LOG FOR 24 HRS. ENDING _6 a.m._ 19_

TIME	WASHERS IN SERVICE								GAS-TEMPERATURES AND PRESSURES								POWER CONSUMED BY GAS. CL. PLANT		WATER USED GAL PER MIN.		GAS CONSUMED CUB. FT. PER MIN.
	PRIMARY				SECONDARY				BEFORE CLEAN'G PLANT		AFTER PRIMARY CLEAN'G		AFTER SECON'Y CLEAN'G		AT HOLDER						
	1	2	3	4	1	2	3	4	P	T	P	T	P	T	P	T	1ST	2ND	1ST	2ND	
6 a.m.																					
7 a.m.																					
8 a.m.																					
9 a.m.																					
10 a.m.																					
11 a.m.																					
12 m.																					
1 p.m.																					
2 p.m.																					
3 p.m.																					
4 p.m.																					
5 p.m.																					
6 p.m.																					
7 p.m.																					
8 p.m.																					
9 p.m.																					
10 p.m.																					
11 p.m.																					
12 night																					
1 a.m.																					
2 a.m.																					
3 a.m.																					
4 a.m.																					
5 a.m.																					
6 a.m.																					
Total [illegible] Avg. Temp., Press. & [illegible]																					

PROPOSED DAILY LOG FOR GAS-CLEANING PLANT FOR BLAST-FURNACE GAS

TO BE ON A STANDARD LETTER-SIZE SHEET $8\frac{1}{2}$ BY 11 IN. HORIZONTAL LINES UNDER THE HEADING AND TO THE RIGHT OF THE RECORD OF WASHERS IN SERVICE TO BE RULED IN BLUE; OTHER LINES IN RED

FOLDER No. 2

FORM 3 ADDENDA B 10-27-'09

------------WORKS--------

Class of Service------------------ GAS POWER PL

No. of Watches-------Hrs. per Watch---------- DATA SHEET FOR MONT

DATE	MAX. PRIM'Y WASHERS	MAX. SEC'RY WASHERS	TOTAL PRIM'Y WASH'R HRS.	TOTAL SEC'RY WASH'R HRS.	GAS CONSUMED CU. FT. 1 MIN.	B.T.U. PER CU. FT.	WATER TO PRIMARY WASHERS GAL. PER MIN.	WATER TO SECONDARY WASHERS GAL. PER MIN.	NO. OF HOURS IN OPERATION ENGINE				AVERAGE KW. ENGINE				GAS TEMP. AT THROTTLE
									1	2	3	4	1	2	3	4	
1																	
2																	
3																	
4																	
5																	
6																	
7																	
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26																	
27																	
28																	
29																	
30																	
31																	
Avg.																	

MONTHLY DATA SHEET FOR BLAST-F

TO BE ON A SHEET 11 BY 17 IN. HORIZONTAL LINES UNDER THE HEA

RKS................. COMPANY

POWER PLANT

FOR MONTH OF............. 19 ....

ENGINES
1......... h.p. capacity
2......... " "
3......... " "
4......... " "

Kw.		Gas Temp. at Throttle	Cooling Water			Gal. Oil Used		Air Temp.	Barometer	
	4		Inlet Deg. F.	Outlet Deg. F.	Gal. per Min.	Cyl.	Eng.			

R BLAST-FURNACE GAS PLANT

DER THE HEADING TO BE RULED IN BLUE; OTHER LINES IN RED

FORM 2 ADDENDA B 10-27-'09

______________WORKS________________ COMPANY

GAS POWER PLANT

DAILY CHEMICAL REPORT FOR 24 HRS. ENDING 6 a.m.______19__

Standard Conditions 62° Fahr. 30" Mercury

TIME	GAS ANALYSIS						B.T.U. BY CALORIMETER	FLUE DUST GR'S. PER CU. FT.			MOISTURE GRAINS PER CU. FT.				TEMP. OF AIR	BAROMETER	
	CO	CO_2	H	CH_4		B.t.u.		BEFORE PRIMARY WASHERS	AFTER PRIMARY WASHERS	IN ENGINE GAS	BEFORE PRIMARY WASHERS	AFTER PRIMARY WASHERS	IN ENGINE GAS	IN AIR			
9 a.m.																	
12 m.																	
3 p.m.																	
6 p.m.																	
9 p.m.																	
12 ngt																	
3 a.m.																	
6 a.m.																	
Average																	

Per Cent of dust removed by Primary Washers_______

Per Cent of dust removed by Secondary Washers_____

REMARKS.

PROPOSED FORM FOR DAILY CHEMICAL REPORT, FOR BLAST-FURNACE GAS PLANT

TO BE ON STANDARD LETTER-SIZE SHEET 8½ BY 11 IN. HORIZONTAL LINES UNDER HEADING TO BE RULED IN BLUE; OTHER LINES IN RED

FORM 4 Addenda B 10-27-'09

WORKS ....COMPANY

GAS POWER PLANT

COST SHEET FOR MONTH OF..................19

	Cost TOTAL	Cost PER KW HR
OPERATION		
SUPPLIES		
Gas @ $.... per 1000 cu. ft delivered to gas cleaning plant..	$.	$.
Water @ $....¢ per 1000 gal........................	$.	$.
Oil, cyl. @ $....¢ per gal..........................	$.	$.
Eng. @ ....¢ per gal..........................	$.	$.
Waste and misc. supplies..........................	$.	$.
LABOR		
Gas cleaning plant..................................	$.	$.
Engineers, Oilers, etc............................	$.	$.
Electricians..	$.	$.
Total Operation Cost....................	$.	$.
REPAIRS		
Gas-Cleaning Plant................................	$.	$.
Gas Engines..	$.	$.
Dynamos..	$.	$.
Engine Auxiliaries................................	$.	$.
Building and Misc................................	$.	$.
Total Repairs............................	$.	$.
Total Operation and Repairs................	$.	$.
PLANT OUTPUT, KW. HRS.		
Kw-hrs. Generated		
" " For Auxiliaries		
Net kw-hrs. Output		

PROPOSED FORM FOR COST SHEETS. TO BE PRINTED ON SHEETS 8½ BY 11 IN.

PRELIMINARY REPORT OF THE STANDARDIZATION COMMITTEE

At the first meeting of the Gas Power Section of The American Society of Mechanical Engineers, held in the Society rooms February 11, 1908, following a paper on Gas Engine and Producer Guarantees, on motion of H. L. Doherty the chairman was empowered to appoint a committee with himself as chairman to standardize so far as seemed practicable the use of terms and the practice of making guarantees of performance for gas engines and producers and the determination of their fulfilment. Accordingly the following committee was named: C. E. Lucke, *Chairman*; H. F. Smith, Louis Doelling, E. T. Adams, J. D. Andrew, J. R. Bibbins, A. West.

2 The duty of the committee was to consider the loose practices which are natural to an industry so young and advancing so rapidly into unknown fields. These bad practices include, besides guarantees of unattainable quantities, incomplete guarantees or guarantees of unmeasurable quantities; or of those measurable in various ways, each of which may give different results, besides incomplete statement of fundamental conditions; all traceable to (*a*) ignorance; (*b*) a not very commendable preference for an indefinite statement that leaves a loophole in case of non-compliance; (*c*) possibly in some rare cases direct intent to deceive. While with the most reputable builders there are cases of honest difficulty, as in the interpretation of the calorific power of gas, the distinction between high and low values and the definition of tar and gas impurities, most of the trouble is with builders who depend on copying previous machines, basing the guarantee of their untested apparatus on hearsay performance of others.

3 Practice due to ignorance or intent to deceive being unprofessional, and injurious to the legitimate development of a new power system which promises more for the conservation of national fuel resources than anything else ever proposed, it is proper that the committee seek to improve the state of affairs by

a Making certain general recommendations acceptable to all good engineers.

b Defining specifically those terms or conditions, the interpretation of which seems to be a matter of agreement and practice.

c Pointing out just where the difficulty lies in the remaining cases, in which, due to insufficient progress, there is not complete understanding or agreement; that due caution may be exercised by all in avoiding misunderstanding.

4 Besides the individual opinions of the committee, some of which were published in The Journal (September 1908, p. 895), as a Progress Report, many builders and their engineers have been consulted, as well as purchasers and in some cases lawyers employed in cases of alleged non-fulfillment arising from the conditions noted; and at more than one meeting of the American Gas Power Society, the questions at issue have been discussed and other opinions obtained.

5 Many of the questions under consideration tend to settle themselves with a proper test code, and the report of the committee has divided itself into (*a*) recommendations not properly part of a code of tests, but related to such a code because many of the most important terms could be definitely fixed only by fixing a mode of measurement; (*b*) a code of tests which would prescribe the procedure for the determination of all quantities entering into the fixing of capacity, efficiency and regulation of both engines and producers.

6 Before effective steps towards the most difficult work of code preparation could be taken, however, a new committee was appointed by the President after the Detroit meeting to codify the testing of gas power apparatus. This committee was discharged before its work had progressed far enough to coöperate with the Standardization Committee; and it was succeeded, on its own recommendation, by a third committee for the revision of all power tests in order to avoid conflict of procedure with necessary new codes, of the various existing codes, either in their original or in revised form.

7 This last committee has held two meetings, but is not as yet in a position to coöperate with the Standardization Committee; this preliminary report is therefore subject to revision when the new gas power code is completed, and its provisions will probably be incorporated in the report. With a complete gas power test code references to these provisions might be very brief; but this code is not in existence and the old gas engine code is of little help, while there exists no producer code at all: references to code procedures are therefore rather full in this preliminary report.

8 To avoid direct conflict with any code, the procedure of direct measurement of important quantities to be defined by that procedure is not recommended but the difficulties and alternatives are pointed out. On the assumption that a gas power plant when bought is adapted to do something, when supplied with some available f el, at a certain rate in pounds of fuel per hour, it may be assumed that guarantees for this class of apparatus will include capacity, efficiency and regulation, of gas producers and engines or complete plants, with auxiliary apparatus included, either as such completely, or in part, or in effect completely or in part, with or without specific reference to the adaptability of the apparatus to the service, and of the coal or gas to the producer or engine.

9 As the capacity of a unit may be considered as generically its output in some unit, and its efficiency the ratio of output to input in the same units, capacity and efficiency of producers and engines or complete plants will be defined when definitions are fixed for:

A Input of producers.
B Output of producers = input of engines (when all gas generated is taken by the engine).
C Output of engines.

To these must be added a definition of regulation of each unit and adaptability or suitability of fuel supply to the needs of the unit.

D Regulation of producers.
E Regulation of engines.
F Adaptability of coal for producers.
G Adaptability of gas for engines.

10 *A* The input of producers is defined by quality of coal and quantity consumed per hour, or B.t.u. per hour in the form of coal or in its identical horsepower equivalent.

11 *B* The output of producers and the input of engines is defined by quality of gas and quantity per hour, which should be taken in connection with the time it can continue, or B.t.u. per hour in the form of gas or its identical horsepower equivalent.

12 *C* The output of an engine is defined by its horsepower or identically equivalent B.t.u. per hour, which should be taken in connection with the time it continues.

13 *D* The regulation of producers is defined by the relative or absolute variation of gas quality at any one of several constant rates of output or at any acceleration rate, positive or negative, of gas

discharge lasting for any time, assuming an always available fuel supply proper in quantity and quality.

14 *E* The regulation of engines is defined by the relative or absolute variation of speed, in terms of complete revolutions in one minute, and by the constancy of its angular velocity or rate of completion of any part of a turn or number of turns, at one of several rates of output or horsepower load, and at any positive or negative acceleration of load lasting for any time, assuming an always available gas supply proper in quantity and quality.

15 *F* The adaptability of coal for producers is defined partly by (*a*) the capability of the producer to gasify it successfully, without undue interruption of service, destruction of apparatus or excessive labor in adjustment or management, comparatively as well as some other fuels considered satisfactory and adopted as a standard; (*b*) the relation of its physical and chemical condition to the peculiar needs of the producer.

16 *G* The adaptability of gas for engines is defined partly by quality and partly by (*a*) characteristics which enable the engine of proper design to use it successfully without undue interruption of service, destruction of parts, excessive labor in adjustment or management, comparatively as well as some other considered satisfactory and adopted as a standard; (*b*) the relation of its physical and chemical condition to the peculiar needs of the engine.

17 This analysis shows that definition of the five general terms or essential conditions is to be accomplished only by defining:

a Quality of coal and variation in quality and rate of change of consumption.

b Quantity of coal consumed per hour by producers.

c B.t.u. equivalent of a given quantity of coal of defined quality.

d Quality of gas and variation in quality.

e Quantity of gas per hour delivered by producers or supplied to engines, and rate of change of delivery or supply.

f B.t.u. equivalent of a given quantity of gas of defined quality.

g Horsepower of engines and variations in horsepower.

h Consecutive time producers may continue to deliver gas of defined quantity and quality, or engines to deliver defined horsepower.

i Number of revolutions, partial or complete, in any time

interval, and change in number with change of time interval chosen or with load conditions of engine.

j Time-interval for the completion of any number of revolutions, or fractions of revolutions, and the change in the time-interval with the number of revolutions chosen for observation or with load conditions of engine.

k Physical or chemical condition of coal, not included in quality definition but affecting adaptability to producer.

l Physical or chemical condition of gases not included in quality definition but affecting adaptability to engine.

QUALITY OF COAL AND ITS VARIATION IN QUALITY

18 Expressions for the quality of coal may be based on a sample as fired, which will be more or less wet; on a sample dried at 210 deg. fahr., or just below the atmospheric boiling point; on a sample heated to a temperature high enough to drive off fixed water, such as water of crystallization, especially important in some lignites. The result will be different in each case, the differences being more important in gas producers than in boilers, as the water vapor from the coal in the producer may pass off as steam, robbing the fire of its total heat as superheated steam above the temperature before firing, or it may react in the fire with carbon, or simply dissociate wholly or in part. Further differences result from the non-uniformity of quality of various samples from the same pile, or successive lots from the same mine, as well as from variations in size, especially in the case of small anthracites. Anthracite of pea size will not have the quality of the same coal of rice size, because of dirt, while mixtures sold for one size will constantly differ from each other, especially when the products of different mines and washeries are compared.

19 With these possibilities of fluctuations in results of expressions for quality, it is clear that rigid limitation to definition of quality of coal, in whatever terms, will be practically impossible. Quality may be expressed by:

a Ultimate analysis, which indicates the quantities of the elements present to enter into the producer reaction; but there is no certainty how they will enter, as, for example, C may be in the form of a hydrocarbon, fixed gas or tar, easily decomposed to lamp black, at the producer temperature or not.

20 While, then, the ultimate-analysis method of defining a coal seems to indicate what is present for the reaction, and so to permit of a judgment of the kind of gas that may result, in reality it does not, nor does it give any clue to the behavior of the coal in the producer.

b Proximate analysis, which gives fixed carbon, volatile, moisture lost at some temperature, and ash, offers a somewhat better indication of behavior; but the nature of the volatile may be widely different, in some cases being almost entirely fixed gas, as for example, CH_4; in others including other hydrocarbons of the tarry order, a variation may have serious consequences.

21 Moreover, there is no standard temperature at which the determination for volatile or moisture is to be made. It is well known that some coals do not yield all their volatile until the fixed carbon cell walls are broken down or weakened by combustion at very high temperatures, while others give off practically all their volatile at fairly low temperatures. While the proximate analysis yields more information concerning the probable behavior of the coal in the producer than the ultimate analysis, it does not permit of any judgment of the gas, or the quality of the coal for the purpose, nor of the heat that the coal may yield.

c Calorific power by calorimeter test is a valuable characteristic, but as different instruments yield different results on parts of the same sample a fair margin of fluctuations must be permitted.

22 In all cases the products of combustion are cooled to their original temperature. When water is formed from the combustion of hydrogen the latent heat of condensation is added and also the heat of the liquid from condensation temperature down to original, except for so much water vapor as will saturate the gases of combustion at the final pressure and temperature. The results of the tests show, within perhaps one or two per cent, the heat to be expected per average pound of coal of the same condition as the sample; this is one of the most valuable characteristics of the coal, though alone it shows little about the adaptability of the coal to producers.

d Calculation of calorific power by empiric formula is no better than the formula and its constants; and as no formula has been found adapted to all classes of coal, giving results in reasonably close agreement with calorimeter test,

the formula must be regarded as a crude approximation, not, is agreed upon as acceptable to the contracting parties.

RECOMMENDATIONS

23 As ordinarily the owner must burn what coal he can buy cheaply, and as coal is usually described by mine name or trade name only, unless the builder of the producer has apparatus at work on the same coal or conditions of equipment, and can arrange for a preliminary trial, no guarantee can be written except by the merest guess. Even were all the quality characteristics known, it is doubtful whether conditions would be much better, *except when the producer builder recognizes them as equivalent to those of another coal, successfully used in his apparatus in another place.*

24 These characteristics of coal expressing its quality are then valuable, and when taken in connection with adaptability characteristics are quite conclusive evidence of *identity*, though they do not permit of prediction. It is therefore recommended:

A That coal quality be defined by (*a*) ultimate analysis of samples dried at 210 deg. fahr.; (*b*) proximate analysis of samples dried at 210 deg. fahr.; (*c*) calorimeter test by a to be avoided unless some formula, whether correct or specified calorimeter, such as Parr, Mahler, Atwater.

B That this definition of quality be considered as a mark of identity with some coal successfully gasified by the producer in question, and not in itself a measure of the satisfactory nature of the coal specified.

C That a variation from values given in *a* and *b*, if not exceeding 5 per cent in any one of its terms, and 2 per cent in *c*, be considered as compliance.

D That producer builders adopt a plan used with success in Germany, of maintaining their own test plant, which may be used to operate their own factories, that they make preliminary trials of a coal, the use of which is contemplated by a purchaser after a provisional sale, the results, if satisfactory, to be incorporated in the final contract, the coal being defined by its trade name, mine or vein, and size. For example, "This producer, when continuously supplied with ——— lb. of Pocahontas coal per hour," will do something, with some results to be named.

QUANTITY OF COAL CONSUMED PER HOUR BY PRODUCERS AND RATE OF CHANGE OF CONSUMPTION

25 The characteristic of producers which renders it difficult to determine the coal consumption, is the thick bed of fuel within brick-lined walls, screened from observation except through small poke holes. With the usual structure it is practically impossible to judge the condition of the bed, or the condition before and after feeding a given weight of coal. The coal consumed may be equal to the coal fed, or more or less may have been consumed than was fed. In boilers a similar problem is met, but the error is minimized by long runs, making the weight of coal fed during the interval many times that resting on the grates at any one time, and so reducing the error as much as desired. A similar practice can be adopted for producers, but to reduce the error of judgment to a value as small as is acceptable in boilers the time must be greater, and in the following proportion

$$\frac{\text{(Time of run for boiler)}}{\text{(Time of run for producer)}} = \frac{\text{(Time to consume .... weight of coal in boiler grate)}}{\text{(Time to consume ... weight of coal on producer bed)}}$$

so that the time of run should be greater, the slower the rate of combustion and the greater the weight in the fire.

26 There are three methods in use for determining the rate at which coal is consumed:

A From the weight of coal fired, and a judgment of the condition of the bed before and after, assisted by measurement of the height of bed and parallel removal of ashes in proportion to coal fed, as indicated by the proximate analysis of the fuel.

27 Judgment of the bed condition at the beginning may be based on the quick building of a new fire, assuming the whole to be in the condition (*a*) of fixed carbon, (*b*) original coal, (*c*) of any fraction of either, and at the end, by quenching, mixing and analysis of the mixture of green coal, partly burned coal and ashes. This method is open to many possible sources of error, as indicated by the three possible assumptions of original condition. It is difficult to obtain a uniform coal-coke-ash mixture for sampling and analysis without grinding, which is usually impracticable. In the ultimate analysis, also, the physical nature of the coal will not be shown, as soot or lampblack or fixed carbon may exist in clinkers and be charged as available carbon, whereas in these forms it is really a dead loss.

B Continuous weighing of the whole producer, when the producer is small enough, may give results of value when the run is long, but not when it is short, as it is difficult to indicate a few pounds on a scale heavy enough to weigh the thousands that may be present in iron, brick, and coal charge.

28 While this might seem to be an ideal method, it also involves a judgment of bed condition, and there is no means of telling whether a loss in weight means fixed carbon burned or volatile and moisture driven off, while a gain in weight may indicate an excess of fuel fired or merely an accumulation of ash. In any case the method must be confined to small producers and shop tests, as it cannot be applied at all to a producer erected in its final condition.

C Gas analysis may indicate a certain weight of carbon in the form of CO, and CO_2, and CH_4, from which, given the ultimate analysis of coal, there can be calculated the weight of coal that could have produced this quantity of these gases. This furnishes an indirect determination of coal consumed from gas analysis, coal analysis and quantity of gas.

29 This method is not even as exact as the two analysis and the gas quantity determination. It is difficult enough because illuminants or rich hydrocarbons and CO_2 will be more or less freely absorbed in the scrubber by the excess of water used and water vapor will be condensed, and also because the carbon in the CO_2 and CO must be assumed as coming from fixed carbon alone, from volatile alone, partly from both, or just from *C*, shown in the ultimate analysis. One of these assumptions must be made or implied before coal weight can be judged from gas analysis and quantity. Several calculations of this kind made on the report data of the United States Geological Survey producer tests failed by a considerable margin to check with the coal weighed, and on these tests greater refinement was used than is possible in ordinary commercial tests on the basis of cost.

RECOMMENDATIONS

30 It is recommended that the weight of coal be determined from the weight of coal fired with these precautions:

A Regular intervals of feeding and uniform amounts.

B Regular removal of ash, preferably in proportion to the coal fired, as indicated by the proximate analysis.

C Constantly maintained level, determined by bar with flat plate at right angles as large as will pass through top holes after leveling the fire. The use of a bar or stick, without a bearing plate extending over considerable bed surface, may lead to error, and cases have been known where a purchaser was intentionally deceived in this way.

D No measurement to begin until bed is at least eight hours old under approximately the load to be used for the run.

E Length of run to be such that the total coal regularly fired is at least equal to ten times the weight of the normal producer content, which is about equivalent to the acceptable 12-hr. run of a boiler test; in which case if an error of coal equivalent to ¼ of the bed contents were made, the error in coal consumed would be effected only about 2½ per cent.

B.T.U. EQUIVALENT OF COAL CONSUMED

31 There may be just as many values for this as combinations can be made of B.t.u. per pound of coal and weight of coal consumed, but as each part of a pound of coal consumed does not represent the same fractional part of the calorific power of the fuel, the value for the volatile weight being much greater than for the fixed carbon, and zero for the ash, it follows that a given loss of weight in the producer does not necessarily represent a heat liberation of this weight of coal.

RECOMMENDATIONS

32 It is recommended that the calorific power of coal, multiplied by the weight consumed, each modified by consideration of the difficulties pointed out, be accepted as giving the B.t.u. equivalent of coal consumed, of calorific power proportionate to the weight; with the understanding that this may not be strictly true.

QUALITY OF GAS

33 From all producers the gas passes through a wet scrubber, supplied with a quantity of water large enough to condense nearly all steam and absorb some rich hydrocarbons and carbon dioxid. The resulting gas is saturated with water vapor, and carries some water in the form of moisture or spray, together with some solid matter, perhaps tar as vapor or as liquid mist and possibly also lamp black or soot. Exact analyses of gas will then differ somewhat with the place of sampling, but in no case does the ordinary volumetric analy-

sis indicate the presence of water vapor, tar or solids. Ordinarily quality of gas is considered as defined by (*A*) volumetric analysis, (*B*) calorific power.

34 *A* Volumetric analysis by the standard apparatus will give O, CO, CO_2 H, and hydrocarbons, assumed to be CH_4, or C_2H_4, which can be separated only by more refined methods when desired. Such standard analysis is comparatively easy but, in unskilled hands, is equally likely to give wrong results. In any case the results are quite certain to vary somewhat with the place of sampling, especially when hot unscrubbed samples are compared with cool scrubbed ones.

35 *B* Calorific power of gases is always determined by burning gas in a calorimeter with continuously circulating water. It is assumed that all the gas supplied to the burner is completely burned, whereas this is not at all the case with weak gas under 100 B.t.u. per cu. ft. except with the exercise of great care and some skill in manipulation of burner and draft. The gas approaches the burner carrying more or less water vapor, and is burned in free air with the ever-present atmospheric moisture; the flue gases leaving the instrument may be reduced in temperature to anything desired, and for exact work this should equal the temperature of the air and gas supply. This implies that these have been made equal, which is not always possible. Corrections may be made approximately but never exactly, because the quantity of air is unknown, as are the moisture content, the precise instrument-radiation factor for room temperature, the air circulation and the conditions of neighboring bodies absorbing and emanating radiant heat.

36 If enough hydrogen free or combined, is present, the flue gases will escape in a saturated condition at the temperature of the water and so carry off heat enough to account for the difference between the vapor carried off by the products of combustion and that brought in by the air and the gas. This is seldom if ever corrected for. If there is only a little hydrogen, and the air dry, all of its water may be carried off in vapor with other products, leading to the impression that there was no hydrogen in the gas.

37 Such a determination of calorific power gives what is termed the high or true value. Subtracting the latent heat at 212 deg. of the water apparently produced by the combustion of hydrogen, the quantity being found by collecting the instrument drops or calculating from gas analysis, there is obtained a lesser value known as the low or effective value. This latent heat is ineffective for raising the temperature of gases during combination, and is not liberated

at all in gas engines. As a matter of fact neither is some of the sensible heat of gases and liquid water effective, so that there may be as many conceptions of the low or effective calorific value as there are assumptions made about it. It is therefore a very indefinite term, of doubtful value in commercial operation, and with a possible value only in scientific investigations of heat liberation in engine cycles. It has come into practice partly because it measures most nearly the heat actually liberated in the gas-engine cylinder in causing a pressure rise, and therefore, that which is effective in preparing for the doing of work at the expense of heat. It has also come into practice because it permits gas-engine guarantees of efficiencies to look better than when made in terms of the high value. Because of its uncertain meaning, however, it has been a source of controversy.

38 Recent investigations by a committee of the American Gas Institute show that different instruments give different values for the same gas, so that it would be best to give the name, in making commercial agreements regarding calorific power. In all cases the instrument reading, with due precautions that the final temperature are approximately equal to gas and air temperatures, without any correction whatever is sufficiently close for most commercial work and is most easily defined.

39 *C* Calorific power may be calculated by formula from volumetric analysis, but this is indirect, and should be used only as a check when direct methods are available.

RECOMMENDATIONS

40 It is recommended that quality of gas be defined by:

a Volumetric analysis near the engine by a specified standard apparatus, and by calorific value B.t.u. per cu. ft. by a specified instrument, taken when the three temperatures, air, gas and flue, differ by not more than 10 deg. fahr. between any two. The calorimeter results are to be accepted without correction.

b That the use of low value and the distinction between high and low value be avoided in commercial work.

c That the volumetric analysis be considered as an indication of the working of the producer, and a guide to its adjustment and manipulation, rather than as a measure of the good quality of the gas, except as noted in the case of hydrogen under adaptability.

d Compliance with any definition of quality or volumetric analysis be considered satisfactory when within 5 per cent of the value of any numerical quantity given.

QUANTITY OF GAS.

41 When the quantity of gas is great in large plants and the calorific power is low, as any but natural gas always is, the problem of its measurement is quite beyond the range of any commercial meter, by reason of the disproportionate cost of meter installation to the value of the information. This fact has led to the proportionate-meter design, the application of pitot and venturi tubes, and the dropping of gas holders. There are available then, these methods of measurement as well as the determination of gas quantity by chemical calculation from the weight of coal, ultimate analysis of coal and volumetric analysis of gas. Any method of measurement must be more or less protected from gas-pressure pulsations due to intermittent suction, especially where many engines synchronize in their suctions from the same main.

42 Holder-drop determinations were perhaps the first practiced, when plants began to get beyond the commercial illuminating gas-meter capacity, as practically all these plants were pressure-producer types delivering pressure gas. Because of the necessarily limited sizes of holders, some containing only five minutes' and few over fifteen minutes' full-load supply, the time of observation was likewise short, shorter than the supply time by reason of time lost in manipulating large gate valves. This involves some error due to the difficulties of measuring by a holder of large diameter dropping rapidly, the more or less bulging plates, the difficulty of averaging the temperature for the whole volume, the surging of the water seal caused by possible change of pressure, especially at the beginning and the end of run. Holders have been known to drop as much or more with the passing of a cloud on a summer's day.

43 Moreover, as the holder filled faster than the normal rate of engine consumption of gas, at the time of filling the flow of air through the producer might easily be too fast, and being succeeded by a period of no flow there would result a gas fluctuating in quality, for which adjustment of design valves cannot be made. These facts are responsible for at least some of the poor results shown by holder-drop tests, yet most of the published data of gas consumption of large engines and delivery of producers were obtained in this way.

The expense of holders is so great and their real value so little in modern systems that this method will probably not be much used in the future, as gas holders will not be installed except for small-capacity pressure regulators.

44 Manufactured direct-reading dial meters give the most positive reading and have a fairly constant error over a considerable time; but all have errors which must be determined by proving, but under the conditions of use as the error may vary with rate of flow, pressure on supply side, loss of pressure, temperature, and pressure pulsation. They are so expensive as to be commercially unavailable for any but small gas capacity systems , except where purchase of gas makes metering a necessity. Some of the larger ones, especially of the proportional type when used with dirty gas, may be very much in error, cases being known where a large meter recorded the same quantity of gas at all loads of the engine, a condition quite impossible with the engine in question. When such meters are new and form part of the permanent installation, mutual acceptance of their readings may be made a matter of agreement between the contracting parties, in which case the condition should be specifically stated.

45 Large gas flows have been fairly successfully measured by venturi meters, but the calculation of flow from the increase of velocity head can be made only when the absolute pressures of the gas flowing and the density of the gas are accurately known. The absolute pressures are determinable by barometer and water manometers; but the throat ratio must be small enough to give at least three inches of water difference in velocity head at the smallest flow to be observed, a condition that may result in a too serious permanent loss of pressure in the pipe line without a pressure booster at maximum load. Pressure fluctuations are practically of no consequence, but intermittent flow may be serious, as pulsation of the velocity-head difference may necessitate a judgment of the fair average. Cases have been known where this pulsation was so great as to make the maximum momentary reading twice the minimum. Pressure regulators, to be of assistance, must be of the gas-holder or large-tank form to equalize the flow. Determination of gas density needed for venturi and pitot calculations requires accurate gas analysis and the taking of temperatures. Installation must not be near any bends or obstructions, and means provided for cleaning the throat frequently.

46 Direct measurement of velocity head by pitot tubes has been used in some cases, but when the piping is sufficiently large to avoid

serious loss of head the velocity head is so small as to involve large errors of observation, especially when the flow is pulsating, even when delicate differential manometers are used. In any case the velocity distribution across the pipe is not uniform, requiring a search across the pipe on at least two diameters at right angles, and a calculation from the data of the mean head. This difficulty is great when the tube is near any bends or valves. To make the pitot readings greater the tube may be used in venturi throats, and its reading used to check those of the venturi meter itself. This is probably the best method known for large flows, but it requires a density determination from gas analysis.

47 Just as the coal consumption in producers may be calculated, as explained, from the ultimate analysis of coal, gas analysis and quantity of gas, so may the quantity of gas be calculated from the two analyses and a measurement of the coal consumed; but this method has so many potential errors as to be almost useless except as a check on other more direct methods.

48 In all cases, meters must be set in by-passes to permit of cleaning just before a measurement, as dirt and water may cause serious error.

RECOMMENDATIONS

49 Correct gas measurement is so difficult or costly, especially when the quantity is large, that its determination should be avoided in commercial relations whenever possible. When one party is responsible for a complete installation, no division should be made and the performance guarantee should include only the performance from producer input to engine output.

a When necessary, large gas measurements may be best made by venturi tubes checked by pitot tubes in the throat; but not too wide a range of flows should be attempted on one throat. Steps should be taken to reduce flow fluctuations to a negligible amount.

b No dial reading of a manufactured meter can be assumed to be correct, unless proved before and after the run under the same pressure, temperature and flow conditions.

c As a matter of contracting agreement, any meter reading or gas quantity determination may be mutually accepted whether correct or not. This is especially convenient when a meter is part of a permanent installation.

d Holder drop tests may be used with fair results where holders contain not less than 15 minutes' supply, if proper precautions are used and care taken to avoid serious positive and negative acceleration of gas flow through the producers.

e A quantity of gas determined by the best method available for any case may be considered as in compliance with the guarantee when not more than 5 per cent above or below guarantee.

B.T.U. EQUIVALENT TO GIVEN QUANTITY OF GAS OF DEFINED QUALITY.

50 This may be taken as the product of the B.t.u. per cu. ft. and the number of the cubic feet determination. When either is a variable its average for a given time is to be taken by the method of mean ordinates, by plotting each reading vertically to a horizontal time base, joining points by straight lines and integrating areas in the usual way.

HORSEPOWER OF ENGINES AND VARIATION IN HORSEPOWER

51 This quantity is generally the prime variable in the series of quantities fixing the general performance of the plant, in as much as all other quantities are usually specified and guaranteed, the quantities being fixed for a given horsepower output or load, or a given change of load. Considerable confusion has resulted from the possibility of various interpretations of engine horsepower and engine load, especially with respect to full load, normal load, overload, maximum load, and no load; the time an engine must run under given load to prove its ability to carry that load and its right to a rating at that load; and from uncertainty of the relations among indicated, brake, effective, and friction horsepower, one being specified or guaranteed which is not directly measurable, but which is to be determined from another that is measurable.

52 On the assumption that a purchaser buys an engine to drive something as indefinitely long as may be necessary, the time involved in proof of ability might be likewise indefinitely long. In this case a 100-h.p. engine would be one that can deliver 100 h.p. as long as supplied with fuel and properly attended. It may be reasonably assumed, however, that a gas engine, after attaining a steady state under the specified load, as indicated by jacket and exhaust tem-

peratures, is able to carry that load indefinitely, if it can do so for twelve hours. The time to reach the steady state for large engines may be taken as not less than three hours from starting, and in small engines not less than half an hour.

53 The use of the term "load" and its modifications is to be discouraged, as a survival of commercial rating, which is an arbitrary rating of horsepower capacity convenient for marking drawings and shop records of manufacture, for the cataloging and tabulation of manufacturer's data. Some horsepower is always implied and it simplifies matters considerably if the numerical value of that horsepower is expressly stated.

54 Statement of horsepower should always be in terms of brake-horsepower whether it can be directly measured or not, but when not, all assumptions made in its evaluation and the methods of indirect determination should be specified to eliminate the personal peculiarities and preferences of different test experts.

55 The speed to be used in all horsepower determinations is best taken as the total number of revolutions by mechanical counter for the entire length of test, divided by the time in minutes. This may be checked by instantaneous readings or intermittent countings taken at *regular* intervals and numerically averaged.

56 Brake-horsepower should always be directly measured when the conditions permit. Its positive nature is so desirable that it is worth considerable trouble to obtain.

57 Direct-connected generators have, when new, efficiency curves well determined, so that the manufacturer's record curve may be accepted. But this method should be then expressly stated and the curve made a part of the agreement. By this method the electrical output may be determined, but never with uncalibrated instruments, especially when alternators have been previously driven in parallel before accurate adjustment of regulation.

58 The horse-power capacity of large engines, direct-connected to pumps or compressors, may best be expressed in terms of compressor or pump indicated horsepower. When the responsibility for the engine and driven parts is divided, as it frequently is, the friction of the parts should be made a matter of preliminary agreement to arrive at each pump or compressor cylinder horsepower, and should then be eliminated from further mention.

59 Large engines, driving machinery by rope or belt transmission and so erected or constructed as to make direct brake-horsepower determination impossible, should include as a condition of the guaran-

tee of brake-horsepower a specified method of indicated horsepower and engine-friction determination to give the guaranteed brake-horsepower by difference. In no case should the difference be accepted as equal to the indicated engine horsepower at zero brake horsepower.

60 Indicated-horsepower determinations of gas engines are very unreliable, cases being known of the indicated values determined by high class experimenters being less than the directly measured brake values—quite sufficient proof of their uncertainty. It is not desirable here to enter into the causes; but in order to eliminate uncertainty and controversy there should be an agreement:

a Precisely how many cards are to be taken, when and how often.

b What make of indicator.

c Proof of calibration of spring.

d What type of reducing motion, and how connected, preferably by drawing.

e How the cards shall be integrated.

f How the speed to be used shall be found.

61 In all cases where there are negative card areas or complete negative cards, as in the two-cycle engine pumps, it should be understood that their work-equivalent is to be subtracted from the work-equivalent of positive areas of cards. The negative or bottom loop of four-cycle cards, when taken with high-scale springs, should be ignored as unmeasurable, except possibly at very light loads when the engine is throttle governed.

62 Engine friction, or ratio of $\frac{\text{b.h.p.}}{\text{i.h.p.}}$, may be made a matter of agreement without any contemplated measurement, from the opinions of contracting parties or by the mutual acceptance of a b.h.p.-i.h.p. curve determined from a similar engine and tested with indicators in the contemplated way with a brake or the electrical generator connected. This method is perhaps the best available, as it permits of using a shop or other good test of a similar engine, which is essentially the practice of the electric-generator manufacturers. The only other method of determination of engine friction is by taking indicated horsepower at no load and assuming it to be constant for all loads. This method is better for steam than gas engines, to which it is extremely ill-suited, as is proved by repeated checks of it against the direct measurement already referred to. Some engines at zero

b.h.p. give cards so small in area, and require at the same time so high a spring scale as to make the area useless within 10 per cent, even if constant. Cases are known where the maximum card area in a series was fully three times the minimum, even with fairly good speed regulation; moreover, the gas port friction varies with load in an unknown way.

TIME-INTERVALS

63 As the original records of guarantee fulfillment tests have a special legal significance, too much care cannot be exercised in their form, especially in the clearness of the statements of quantities and time of determination. For this reason the method of recording time and time-intervals may properly be a matter of agreement; time clocks and date stamps may be used at the time of taking each individual observation, or all readings and records may be made at the stroke of a bell and brought to the bell operator signed, for stamping just after taking.

REVOLUTIONS, PARTIAL OR COMPLETE, AND TIME INTERVAL

64 Engine speed measurements are data in

a Horsepower calculations in which for indicated horsepower there is needed the number of similar cycles executed in one minute rather than the actual speed at any one time; and for brake-horsepower direct measurements the average speed of overcoming the resistance, or the total distance that would be traversed by the point of resistance in one minute, if free: this also does not involve the real speed at any minute.

b Proof of speed regulation or ability of the engine to maintain a given value for any time interval.

65 When engines are to drive alternators in parallel, the rate of change of speed in extremely small time-intervals, down to hundred parts of a second, is important. As any part of a complete revolution, divided by the time in minutes, is just as properly the engine speed in r.p.m. as the revolutions completed in a whole hour divided by sixty, and as these two may be very different indeed in amount and constancy, even with constant load, and doubly so for sudden load change, it is evident that speed definition in terms of revolutions per minute leads to endless controversy.

66 In commercial transactions one method or instrument should be specified as a part of the agreement, making its results the definition of the term speed. In fact, several different meanings may very properly be incorporated in the same guarantee, each defined by its own instrument or method of measurement.

67 There are available a variety of possible ways of determining speed to be noted. These may be applied to the half-speed shaft of four-cycle engines, the main shaft, cam shaft or governor spindle or any other rotating part; but as these will all give different results, the place of attachment must be specified when delicate regulation is in question. The method of attachment is also important, as counters and tachometers may be gear-driven, direct-driven by pin or disc clutch or belt, or held to a punched lathe center and driven by a triangular prism with sharp edges to avoid slip, or by a rubber cone in a plain lathe center, which may slip considerably.

68 The following methods for speed determination are in use:

a Hand counter and stop-watch, counter held to lathe center for one minute, more or less, or read for one minute, more or less, without application at beginning, or removal at end of interval.

b Mechanical counter and adding machine, read at long intervals of time.

c Hand tachometer, mechanical, electrical, or hydraulic.

69 All of these tachometers give instantaneous readings, more or less lagging and seldom agreeing with the average of counters; some have permanent instrument errors varying with time of application (electric), or with a great variety of other conditions; and all involve slippage at the point of application.

d Belted, geared or direct-driven tachometers, intended to eliminate slippage at the point of application.

70 With the belted type, if the belt slips or flaps the speed fluctuations will be dampened, and the tachometer will not indicate them; while the geared type of tachometer may involve back lash. These are also made of the recording type by the addition of pencils, or pens and time-clock-driven paper. All require calibration, preferably by their makers, and their range of accuracy is limited.

e Chronograph and seconds-clock apparatus, though expensive, are by far the best for complete revolutions and not too small parts of revolutions.

f Frequency meters on alternator circuits are good speed indicators in connection with the number of poles, and in some cases no other is needed.

g Positively driven small alternators, with frequency meters, especially of the tuning fork synchronizing type, are good but expensive instantaneous speed indicators within limits.

h The use of the tuning fork to mark the time on smoked paper over a driven drum is a poor method sometimes used.

i Cross-current measurement in parallel alternator circuits is the best indication at any instant of the momentary difference in speed of the two machines. It is most easily made but requires more electrical instruments than are found on the average switchboard.

71 It seems further desirable, in accordance with the recommendations concerning the substitution of b.h.p. figures for fractional or normal loads, to stop the use of per cent variations in speed and substitute two limiting speeds. For example, instead of stating that at a constant load of 100 h.p., the engine speed will be 200 r.p.m., or more than 2 per cent above or below, the matter can be put in the form

Constant Engine Brake Horsepower:	100	50	00
Engine speed limits over 15 min., by mechanical counter attached to cam shaft,			
maximum	102	105	109
mimimum	98	99	101

Great care must be exercised after a load change, to indicate not only the mode of speed measurement but also when the measurement should begin and end.

72 The instrument should be specified, and the maker's name and the size should be given, and if important, subject to maker's calibration before and after test.

PHYSICAL OR CHEMICAL CONDITION OF COAL, NOT INCLUDED IN QUALITY BUT AFFECTING ADAPTABILITY TO THE PRODUCER

73 There are certain characteristics of coals closely related to their availability for producers and to their fulfillment of conditions not ordinarily considered as fixing their quality. These are:

a Tendency to cake and coke. This depends on temperature; whether after coking there will be left hard or soft coke;

in large or small lumps; of porous or solid character; easily gasified as fixed carbon or not; tar-free when coked or not.

b Quantity of tar set free in coking and combustion.

c Clinkering tendency, associated with fusibility of ash, or its tendency to flux with the producer brick work or other filling.

d Form of sulphur, indicating a tendency to remain in the ash and promote clinkering, or to gasify and so to corrode iron work, especially where water is encountered.

e Uniformity of size. Especially with anthracites a mixture of large and small sizes seems to pack the bed and resist blast more than a uniform size.

f Water of crystallization. Its loss may cause large lumps of lignite to break down on heating, into pieces varying from sand to gravel in size, with a tendency to pack the bed.

g State of the fixed carbon, whether easily gasified or not as certain forms approach the lampblack condition, which is practically ungasifiable in an ordinary producer.

h Nature of the volatile, whether easily split into soot or not, or whether the condensible tars can be fixed by heating.

i Strength of the lumps of original coal or its coke, measuring the tendency to crush under the weight of upper layers; especially important with peats and some briquettes.

RECOMMENDATIONS

74 As there is no known way to fix any of these characteristics, some of which are of essentially practical importance, there is need of great caution in guaranteeing the performance of any coal which has not been tried.

PHYSICAL OR CHEMICAL CONDITION OF GAS NOT INCLUDED IN QUALITY BUT AFFECTING ADAPTABILITY TO THE ENGINE

75 Just as certain physical and chemical properties characterize coal in its relation to the producer, properties yet undefinable because in an early stage of development, yet quite essential in practical operation, a similar condition exists with gases, but to a less acute degree. Some of these gas characteristics are:

a Presence of gritty solids tending to grind out bearing or rubbing surfaces.

b Presence of solids, whether gritty or not, tending to fill up openings and collect in the combustion chamber in non-conducting layers, easily becoming red hot and causing pre-ignitions.

c Presence and amount of lampblack, which, besides the tendencies under *a* and *b*, may, with oil or water, form a gum on the bearing surfaces, especially the regulating valves.

d Presence and amount of tar in vapor, liquid or mist form, and possibility of picking up from coating on piping and other parts. Tar is one of the most serious causes of disturbance of valve movement, especially sliding regulating valves, besides caking hard on the combustion chamber, where it causes preignition.

e Amount of hydrogen or illuminants, or relation of the amounts to other substances, significant in the sense that certain relative quantities may have low ignition temperatures and cause pre-ignition, the tendency toward which is different in practically every engine.

f Temperature of the gas. This affects the weight of charge to which the power of the engine is in direct proportion; so that both charge and gas must be as cool as possible.

g Pressure and fluctuations.

76 This may affect both power and efficiency of the engine, as the gas flow to the engine is proportional approximately to the square root of sum of gas pressure above atmosphere and cylinder vacuum caused by suction, while the air flow is similarly dependent on cylinder vacuum alone. Any setting of the mixing valve for correct mixture must be made for some gas pressure, and any change of pressure, however momentary, will admit more or less than the original quantity of gas, decreasing the power in both cases, and where excess enters wasting it with decreased efficiency. The importance of this fact even during one suction should be more widely recognized.

GENERAL RECOMMENDATIONS

77 All terms made in a guarantee should be defined. All guaranteed quantities must be capable of measurement, and only one acceptable mode of measurement should be specified.

78 There should be no conflicts of quantities.

79 Builders best serve their own interest, when units are in terms most satisfactory to the purchaser, and hence involve only input and output for definite fuel, horsepower and time.

80 Builders' ratings are matters of private interest to facilitate shop procedure and cataloging; they should not be used in guarantees, but may be used in describing the engine to identify it with public records.

81 Standard forms of specification and guarantee are undesirable as cumbersome and sometimes inadequate, actual conditions being seldom twice the same.

82 The legal nature of a guarantee must be kept in mind, especially as the terms and procedure involved are not matters of common knowledge; in case of controversy courts must interpret by attempts to get at accepted practice in the art through experts, in the legal sense, who may not be so in the scientific and engineering sense and may be more interested in protecting their client than in arriving at truth.

83 Capability should not be guaranteed, but only actual performance. Failure to meet a test requirement does not prove lack of capability. A given gas having repeatedly produced an m.e.p. of 80 in an engine, another similar engine is capable of 100 h.p., when its dimensions and speed with m.e.p. of 80 figure 100 h.p., even though it never did so.

84 The time element in any observation or number of observations, per result or method of averaging, should always be kept in mind. How long a run is necessary to prove the h.p., how long a count to get the r.p.m., and how often, how many tests to prove the b.t.u. per cu. ft. of gas, and how long each, are all questions to be understood by both parties.

85 Steady conditions should be established, or be expressly stated as prerequisite and not be left as implied.

86 Substantial fulfillment of some things is fulfillment, whereas literal fulfillment is necessary for others. Margins should be established and agreed upon.

87 Expense of test and conduct should be borne by the builder except when the purchaser imposes unfair requirements, in which case he should be informed of the cost and be required to bear it. This is especially important when long runs are contemplated, requiring relays of skilled observers, or when gas measurements require meters, or where the purchaser's expert tries to show how much he knows by insisting on absurd refinement or untried schemes of test invented by himself.

88 The output energy of the producers equals input energy of the engines without correction or qualification, except when some gas

generated is used for auxiliary purposes. For complete plants the guarantee should be over all performance only.

89 When complete plants are guaranteed by one party the guarantee should relate only to producer input and engine output.

90 In tests for fulfillment no other data than that required by contract conditions should be taken, with no exceptions.

91 The place and time of operation and test for fulfillment should always be expressly stated.

92 Builders should always expressly reserve the right, and sufficient time, for preliminary tests for adjustment and *take complete* advantage of the opportunity.

93 Original records, with signatures and date stamps, should be kept for all fulfillment test data and it should be expressly agreed that a copy be given to the party not in possession.

Respectfully submitted,

C. E. Lucke, *Chairman*	
Arthur West	
J. R. Bibbins	*Gas Power*
E. T. Adams	*Standardization*
James D. Andrew	*Committee*
H. F. Smith	
Louis C. Doelling	

ACCESSIONS TO THE LIBRARY

This list includes only accessions to the library of this Society, included in the Engineering Library. Lists of accessions to the libraries of the A.I.E.E. and A.I.M.E can be secured on request from Calvin W. Rice, Secretary, Am.Soc.M.E.

American Railway Association. Statistical Bulletin No. 56, 57–A. *Chicago, Ill., 1909.*

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Concrete. By J. C. Trautwine, Jr., and J. C. Trautwine, 3d. *New York, J. Wiley & Sons, 1909.* Gift of authors.

Contributions to Economic Geology, 1908. Pt. 1. Metals and Non-metals, except Fuels. (Bulletin No. 380, U. S. Geological Survey.) By C. W. Hayes and W. Lindgren. *Washington, Govt., 1909.*

Effect of Oxygen in Coal. (Bulletin No. 382, U. S. Geological Survey.) By D. White. *Washington, Govt., 1909.*

Expenditure of Public Money. Gift of Civic League of San Francisco.

Fauna of the Caney Shale of Oklahoma. (Bulletin No. 377, U. S. Geological Survey.) By G. H. Girty. *Washington, Govt., 1909.*

Geological Reconnaissance in Northern Idaho and Northwestern Montana. (Bulletin No. 384, U. S. Geological Survey.) By F. C. Calkins. *Washington, Govt., 1909.*

Geology and Ore Deposits of Goldfield, Nevada. (Professional Paper No. 66, U. S. Geological Survey.) By F. L. Ransome. *Washington, Govt., 1909.*

Monthly Meteorological Summary for 1907–1908. (U. S. Weather Bureau, Nome, Alaska.) Gift of Arthur Gibson.

Notes on Explosive Mine Gases and Dusts. (Bulletin No. 383, U. S. Geological Survey.) By R. T. Chamberlin. *Washington, Govt., 1909.*

Ohio Engineering Society. Report of Thirtieth Annual Meeting. *Columbus, O., 1909.* Gift of the Society.

Oscillations de Lacet des Véhicules de Chemins de Fer. By Georges Marié. *Paris, H. Dunod and E. Pinat, 1909.*

Papers on the Conservation of Mineral Resources. (Bulletin No. 394, U. S. Geological Survey.) *Washington, Govt., 1909.*

Papers on the Conservation of Water Resources. (Water Supply Paper No. 234, U. S. Geological Survey.) *Washington, Govt., 1909.*

Pre-Cambrian Geology of North America. (Bulletin No. 360, U. S. Geological Survey.) By C. R. Van Hise and C. K. Leith. *Washington, Govt., 1909.*

Providence Association of Mechanical Engineers. Constitution, By-Laws and List of Members. 1907–1908. *Pawtucket, R. I.*

Purification of Some Textile and Other Factory Wastes. (Water Supply Paper No. 235, U. S. Geological Survey.) By H. Stabler and G. H. Pratt. *Washington, Govt., 1909.*

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Report on Electrolysis. By W. S. Williams. *1909.* Gift of Civic League of San Francisco.

Scaling and Corroding Substances and their Elimination from Water for Boilers. By J. C. W. Greth. (Reprint from Proceedings of Scranton Engineers Club, June 1909.) Gift of W. B. Scaife & Sons Co.

Smokeless Combustion of Coal in Boiler Plants. (Bulletin No. 373, U. S. Geological Survey.) By D. T. Randall & H. W. Weeks. *Washington, Govt., 1909.*

Structural Materials in Parts of Oregon and Washington. (Bulletin No. 387, U. S. Geological Survey.) By P. H. Darton. *Washington, Govt., 1909.*

Surface Water Supply of the United States, 1907–1908. Pt. 2. South Atlantic Coast and Eastern Gulf of Mexico. (Water Supply Paper No. 242, U. S. Geological Survey.) By M. R. Hall and R. H. Bolster. *Washington, Govt., 1909.*

Testing and Performance of Steam Generating Apparatus. By A. Bement. (Reprint from Vol. 1, Transactions, American Institute of Chemical Engineers, 1908.)

Underground Water Resources of Connecticut. (Water Supply Paper No. 232, U. S. Geological Survey.) By H. E. Gregory. *Washington, Govt., 1909.*

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EXCHANGES

Design of Submarines. By N. F. Hay. (Advance paper, Society of Naval Architects and Marine Engineers, November 1909.)

Effect of Parallel Middle Body upon Resistance. By D. W. Taylor. (Advance paper, Society of Naval Architects and Marine Engineers, November 1909.

Evolution of Screw Propulsion in the United States. By C. H. Cramp. (Advance paper, Society of Naval Architects and Marine Engineers, November 1909.)

Foreign Trade Merchant Marine of the United States: Can it be Revived? By G. W. Dickie. (Advance paper, Society of Naval Architects and Marine Engineers, November 1909.)

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MANCHESTER ASSOCIATION OF ENGINEERS. *Transactions.* 1908–1909. *Manchester, 1909*

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NORTHEAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS. *Transactions.* Vol. 25. *Newcastle-upon-Tyne, 1909.*

PRODUCER GAS BOAT MARENGING. By H. L. Aldrich. (Advance paper, Society of Naval Architects and Marine Engineers, November, 1909.)

RIVETS IN TENSION. By R. Curr. (Advance paper, Society of Naval Architects and Marine Engineers, November 1909.)

SOME SHIP-SHAPED STREAM FORMS. By Wm. McEntree. (Advance paper, Society of Naval Architects and Marine Engineers, November 1909.)

EMPLOYMENT BULLETIN

The Society has always considered it a special obligation and pleasant duty to be the medium of securing better positions for its members. The Secretary gives this his personal attention and is most anxious to receive requests both for positions and for men available. Notices are not repeated except upon special request. Copy for notices in this Bulletin should be received before the 15th of the month. The list of men available is made up of members of the Society, and these are on file, with the names of other good men not members of the Society who are capable of filling responsible positions. Information will be sent upon application.

POSITIONS AVAILABLE

085 Business opportunity. Exceptional offer will be made to the right man, who can promote considerable additional capital required for a growing business; one who has a record as a good business manager and can show himself competent to financier a shop. Shop located in the Central West and engaged in building high-class engine work; strictly modern plant, in operation day and night since January. Give full particulars of past experience, etc.

086 Designer. A particularly able designer of alternating current generators and motors, for a leading position in well known electrical manufacturing company near New York.

087 Superintendent for eastern boiler shop. Must be temperate, able to lay out work and to estimate; good handler of men. State experience, and salary expected.

088 First-class experienced pump designer, man with number of years experience and able to go ahead with new designs.

MEN AVAILABLE

329 Member desires position as factory manager or mechanical engineer. Has had wide experience developing new inventions. Best references.

330 Mechanical engineer, ten years experience foundry and machine shop, construction, boiler testing and selling; office experience and drafting; four years wool manufacturing.

331 Member, at present superintendent in large machine shop, where he has been for several years, would like a change of locality; 19 years experience in manufacture of steam engines, steam turbines, and machine tools. Capable of filling first-class position.

332 Mechanical engineer, Associate Member, technical graduate, eight years experience in steel works and general office, desires position as chief engineer, superintendent or sales engineer. Familiar with all kinds of steel works machinery, construction work, and accounting; can handle men, cut down costs, and systematize general office work.

333 Superintendent and manager desires change for larger opportunity. High-grade organizer and executive. Specialized on equipment, production, and costs.

334 Mechanical and electrical engineer desires position (East preferred) as assistant to mill engineer or manager of works on the design and equipment of power plants and industrial works; age forty-three. Has had six years experience as engineer of works with two important manufacturing companies.

CHANGES IN MEMBERSHIP

CHANGES OF ADDRESS

ABBOTT, William L. (1891), Manager, 1907–1910; Ch. Operating Engr., Commonwealth Edison Co., 139 Adams St., and *for mail*, 4616 Beacon St., Chicago, Ill.

ABORN, George P. (1889; 1892), Mgr., Geo. F. Blake Mfg. Co., East Cambridge, and *for mail*, 55 Burroughs St., Jamaica Plain, Mass.

ARNOLD, Edwin E. (1900; 1906), Metal Products Co., 226 Abbott St., Detroit, Mich.

BANTA, Earle J. (1907), Ch. Engr., Cinn. Equipment Co., Cincinnati, O.

BARRETT, Walter A. (Junior, 1906), Sales Dept., Bass Fdy. & Mch. Co., and *for mail*, 714 Woldwood Ave., Fort Wayne, Ind.

BARTON, Henry L. (1903), V. P., Metal Products Co., 226 Abbott St., Detroit, Mich.

BASINGER, James G. (1907), Civil Engr., 52 Broadway, and *for mail*, 523 W. 121st St., New York, N. Y.

BIXLER, Harry Z. (1907), Worth Bros. Co., Coatesville, Pa.

BOGARDUS, Henry A. (Associate, 1907), Henry A. Bogardus & Co., 159 W. Huron St., Chicago, Ill.

BOLLER, Alfred P., Jr. (1901), 45 E. 17th St., New York, N. Y., and East Orange, N J.

BRANCH, Joseph G. (1904), Pres., Branch Publishing Co., 46 Van Buren St., Chicago, Ill.

CARROLL, Alexander W. (1905), 524 Westminster Ave., Elizabeth, N. J.

CROOK, Geo. Louis (1905), Factory Mgr., E–M–F Co., Plant 3, Detroit, Mich.

DEAN, Arthur M. (Junior, 1907), Matheson Motor Car Co., Wilkesbarre, Pa.

FARWELL, E. S. (1899), with George F. Hardy, 309 Broadway, New York, N. Y.

FRANKENBERG, Geo. T. (Associate, 1907), Mech. Engr., Ralston Steel Car Co., East Columbus, and *far mail*, 1290 Franklin Ave., Columbus, O.

HAGERTY, Walter W. (Junior, 1905), Y. M. C. A., Pottsville, Pa.

HALE, Robt. Sever (1894; 1897; 1899), Supt., Sales Dept., Edison Elec. Ill. Co., 39 Boylston St., and *for mail*, Tennis and Racquet Club, 939 Boylston St., Boston, Mass.

HANSON, Walter S. (Associate, 1902), Pres., El Reno Alfalfa Milling Co., El Reno, Okla.

HENDEE, Edward Thomas (Associate, 1908), Mgr. Mchy. Dept., Joseph T. Ryerson & Son, and *for mail*, 4143 Sheridan Rd., Chicago, Ill.

HORNE, Harold F. (Junior, 1909), 595 West Side Ave., Jersey City, N. J.

HURLEY, Daniel (Junior, 1904), 1329 11th St., N. W., Washington, D. C.

JOHNSON, Lewis (1880), P. O. Box 447, Covington, La.

KRUESI, August H. (1901; Associate, 1904), Designing Engr. in Charge Constr. Engrg., Genl. Elec. Co., and 22 Washington Ave., Schenectady, N. Y.

KRYZANOWSKY, Constant J. (Associate, 1902), Ch. Engr., Reliance Motor Truck Co., Cor. King and Adams Sts., Owosso, Mich.

LILLIBRIDGE, Ray D. (Associate, 1907), 100 Broadway, and P. O. Box 824, New York, N. Y.

MILLER, Herman G. (1908), Mech. Engr., Rubber Regenerating Co., and *for mail*, 427 N. Calhoun St., Mishawaka, Ind.

MILLHOLLAND, William Knox (1907), Secy., Internatl. Mch. Tool. Co., and *for mail*, 3446 N. Capitol Ave., Indianapolis, Ind.

MOSS, Sanford A. (1903), Engr. Turbine Research Dept., Genl. Elec. Co., West Lynn, and 36 Sachem St., Lynn, Mass.

MOWERY, John N. (1906), Asst. M. M., Lehigh Valley R. R. Offices, Auburn, N. Y.

ORCUTT, Harry F. L. (1900), Hartford, Sutton-on-Sea, Lings, England.

PHELPS, Charles C. (Junior, 1909), Editor Steam, 114 Liberty St., New York, N. Y.

POWEL, Samuel W. (1880), Asst. Mch. Engr., Am. Radiator Co., and *for mail*, 679 Auburn Ave., Buffalo, N. Y.

RAPLEY, Frederick H. (1905), 11 Thurlow Rd., Hempstead, London, N. W., England.

SMITH, Wm. E. (Junior, 1908), Babcock & Wilcox Co., and *for mail*, 318 E. Park Ave., Barberton, O.

STEBBINS, Theodore (1903), Herrick & Stebbins, 14–16 Church St., New York, N. Y.

SYMINGTON, E. Harrison (Associate, 1903), Wks. Sales Mgr., T. H. Symington Co., Rochester, N. Y.

VALENTINE, Warren P. (Junior, 1904), Summerlea Apts., Summerlea and Elwood Sts., Pittsburg, Pa.

WATERMAN, Charles (1903), Supt., Southern Motor Wks., Jackson, Tenn.

WEINLAND, Hermon G. (Junior, 1905), Mech. Engr., Safety Emery Wheel Co., and *for mail*, 226 W. College Ave., Springfield, O.

WHITING, Richard A. (Junior, 1909), Instr. Exper. Engrg., Stevens Inst. of Tech., Hoboken, and *for mail*, Oradell, Bergen Co., N. J.

WRIGHT, Ernest N. (1890), Cons. Engr., 691 Huntington Terrace, Pasadena, Cal.

NEW MEMBERS

BRYCE, James Wares (Associate, 1909), Goss & Bryce, 76 William St., New York, N. Y.

KOENIG, Samuel L. (Junior, 1909), U. S. Engrs. Dredge, Capt. C. W. Howell, Galveston, Tex.

MEYER, C. Louis (Junior, 1909), 210 S. 36th St., Omaha, Neb.

SANGUINETTI, Philip C. (Associate, 1909), Marwick, Mitchell & Co., 79 Wall St., New York, N. Y.

GAS POWER SECTION

CHANGES OF ADDRESS

BULMER, Wm. Carr (Affiliate, 1909), 882, Mahoning Ave., Youngstown, O.

NEW MEMBERS

BECK, M. (Affiliate, 1909), Ch. Engr., Alamo Mfg. Co., Hillsdale, Mich.
CUTLER, Frank G. (Affiliate, 1909), Steam Engr., Tenn. Coal, Iron & R. R. Co., Ensley, Tenn.
HAYWARD, Charles B. (Affiliate, 1909), Editor, The Automobile, 119 W. 25th St., New York, N. Y.
TILDSLEY, Joshua C. (Affiliate, 1909), Ch. Engr., Martin Sta., P. G. & E. Co., Bay Shore Dist., San Francisco, Cal.
WILSON, R. A. (Affiliate, 1909), Constr. Engr., Carnegie Steel Co., Ohio Wks., Youngstown, O.

STUDENT SECTION

CHANGES OF ADDRESS

HAYNES, H. Hasbrouck (Student, 1909), Stevens Inst., Hoboken, N. J.
JEHLE, Ferdinand (Student, 1909), 101 E. John St., Champaign, Ill.
KELLOGG, E. W. (Student, 1909), 1112 La Salle Ave., Chicago, Ill.
LURIE, A. N. (Student, 1909), present address unknown.
MANSFIELD, W. M (Student, 1909), 582 Jackson St., Milwaukee, Wis.
SCHUSTER, George (Student, 1909), 407 Stoughton St., Champaign, Ill.

COMING MEETINGS

December and January

Secretaries or members of societies whose meetings are of interest to engineers are invited to send in their notices for publication in this department. Such notices should be in the editor's hands by the 18th of the month preceding the meeting.

ALBERTA ASSOCIATION OF ARCHITECTS
January, annual meeting, Edmonton. Secy., H. M. Whiddington, Strathcona.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE
December 27, Boston, Mass. Secy., L. O. Howard, Smithsonian Institution, Washington, D. C.

AMERICAN FEDERATION OF TEACHERS OF MATHEMATICS
December 28, 29, annual meeting, Baltimore, Md. Secy., C. R. Mann, University of Chicago.

AMERICAN INSTITUTE OF ARCHITECTS
December 14–16, annual convention, Washington, D. C. Secy., Glenn Brown, Octagon Bldg.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS
December 8–10, annual meeting, Philadelphia, Pa. Secy., J. C. Olsen, Polytechnic Institute, Brooklyn, N. Y.

AMERICAN SOCIETY OF CIVIL ENGINEERS
December 1–15, 220 W. 57th St., New York. Papers: The Crosstown Tunnel of the Pennsylvania Railroad, J. H. Brace and Francis Mason. The East River Tunnels of the Pennsylvania Railroad, J. H. Brace, Francis Mason, S. H. Woodard. Secy., C. W. Hunt.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS
January 18–20, annual meeting, 29 W. 39th St., New York. Secy., W. M. Mackay, Box 1818.

AMERICAN SOCIETY OF HUNGARIAN ENGINEERS AND ARCHITECTS
December 4, Room 703, 29 W. 39th St., New York. Paper: High Structures in New York, Alexander Pollacsek. Secy., Zoltan de Nemeth, 907 Prospect Ave.

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
December 7–10, annual meeting, 29 W. 39th St., New York. December 11, St. Louis; December 17, Boston, Mass. July 26–29, 1910, joint meeting with Institution of Mechanical Engineers, Great Britain. Secy., Calvin W. Rice, New York.

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS
December 28, 29, annual meeting, Ames, Ia. Secy., L. W. Chase, Univ. of Neb., Lincoln, Neb.

AMERICAN SOCIETY OF REFRIGERATING ENGINEERS
December 6, New York meeting. Secy., W. H. Ross, 154 Nassau St.

ASSOCIATION OF AMERICAN PORTLAND CEMENT MANUFACTURERS
December 14, 15, annual meeting, New York. Secy., P. H. Wilson, Land Title Bldg., Philadelphia, Pa.

ASSOCIATION OF TRANSPORTATION AND CAR ACCOUNTING OFFICERS
December 14, 15, Chattanooga, Tenn. Secy., G. P. Conard, 24 Park Pl., New York.

BOSTON SOCIETY OF ARCHITECTS
January 4, annual meeting. Secy., E. J. Lewis, Jr., 9 Park St.

BOSTON SOCIETY OF CIVIL ENGINEERS
January 26, annual meeting, Chipman Hall, Tremont Temple. Secy., S. E. Tinkham, 60 City Hall.

BROOKLYN ENGINEERS' CLUB
December 2, 117 Remsen St., Brooklyn, N. Y. Paper: Steel Sheet Piling, A. R. Archer. Secy., Joseph Strachan.

CANADIAN SOCIETY OF CIVIL ENGINEERS
Quebec Branch, January 21, annual meeting, Montreal. Secy., C. H. McLeod, 413 Dorchester St., W.

CENTRAL RAILWAY AND ENGINEERING CLUB OF CANADA
December 21, Prince George Hotel, Toronto. Papers: Gas Manufacture, C. G. Herring. Secy., C. J. Worth, Union Sta.

CIVIL ENGINEERS SOCIETY OF ST. PAUL
January 10, annual meeting. Old State Capitol Bldg., 8 p.m. Secy., D. F. Jurgensen, 116 Winter St.

COLORADO SCIENTIFIC SOCIETY
December 18, annual meeting, Denver. Secy., Dr. W. A. Johnston, 801 Symes Bldg.

ENGINEERS CLUB OF ST. LOUIS
December 1, annual convention, 3817 Olive St. Secy., A. S. Langdorf, Washington University.

ENGINEERS SOCIETY OF PENNSYLVANIA
January 4, annual meeting, Harrisburg. Secy., E. R. Dasher, Gilbert Bldg.

ENGINEERS SOCIETY OF WESTERN PENNSYLVANIA
January 18, annual meeting. Secy., E. K. Hiles, 803 Fulton Bldg., Pittsburg.

FRANKLIN INSTITUTE
December 10, January 28, Witherspoon Hall, Philadelphia, Pa. Lectures: A Safer America, W. H. Tolman; Road Administration and Maintenance, L. W. Page.

INDIANA ENGINEERING SOCIETY
January 14–16, annual convention, Indianapolis. Secy., Chas. Brossmann, Union Trust Bldg.

MICHIGAN ENGINEERING SOCIETY
January 12–14, annual meeting, Lansing. Secy., Alba L. Holmes, 574 Wealthy Ave., Grand Rapids.

MONTANA SOCIETY OF ENGINEERS
January 6–8, annual meeting, Butte. Secy., Clinton H. Moore

NATIONAL ASSOCIATION OF AUTOMOBILE MANUFACTURERS
January 12, annual meeting, Madison Square Garden, New York. Secy., Benjamin Briscoe, 7 E. 42d St.

NATIONAL COMMERCIAL GAS ASSOCIATION
December 12, 14, annual convention, Madison Square Garden, New York. Secy., L. S. Bigelow, Light Publishing Co., Willimantic, Conn.

NATIONAL GAS AND GASOLENE ENGINE ASSOCIATION
November 30, December 1, 2, LaSalle Hotel, Chicago, Ill. Secy., Albert Stritmatter, Cincinnati, O.

NATIONAL SOCIETY FOR THE PROMOTION OF INDUSTRIAL EDUCATION
December 2–4, annual convention, Milwaukee, Wis. Exhibition of Trade School Work, C. R. Richards, Mem.Am.Soc.M.E. Secy., J. C. Monaghan, 20 W. 44th St., New York.

NEW ENGLAND RAILROAD CLUB
December 14, Copley Square Hotel, Boston, Mass. Paper: The Curtis Turbine Applied to Marine Propulsion, Chas. B. Edwards. Secy., Geo. H, Frazier, 10 Oliver St.

NEW ENGLAND WATER WORKS ASSOCIATION
January 12, annual meeting. Secy., Willard Kent, 715 Tremont Temple, Boston, Mass.

NEW JERSEY SANITARY ASSOCIATION
December 3, 4, annual meeting, Laurel-in-the-Pines, Lakewood. Secy., J. A. Exton, 75 Beech St., Arlington.

NOVA SCOTIA SOCIETY OF ENGINEERS
December 9, N. S. Telephone Co. Building, Hollis St., Halifax, 8.15 p.m. Paper: Improvements of the Telephone, J. H. Winfield. Secy., J. L. Allan, Provincial Engrs.' Office, Halifax.

RICHMOND RAILROAD CLUB
December 13, January 11. Lectures: Block Signals, Chas. Stephens; Terminal Freight Handling, G. H. Condict. Secy., F. O. Robinson.

ROCHESTER ENGINEERING SOCIETY
December 10, annual meeting. Secy., John F. Skinner, 54 City Hall.

SHORT LINE RAILROAD ASSOCIATION
December 14, annual meeting, New York. Secy., J. N. Drake, 60 Wall St.

WESTERN RAILROAD ASSOCIATION
January, annual meeting, Chicago. Secy., E. P. Amory, Marquette Bldg.

WESTERN SOCIETY OF ENGINEERS
December papers: The Panama Railroad, Ralph Budd; Reinforced Concrete Trestles, C. H. Cartlidge. Secy., J. H. Warder, 1735 Monadnock Bldg., Chicago.

MEETINGS TO BE HELD IN THE ENGINEERING BUILDING

Date December	Society	Secretary	Time
1	Wireless Institute	S. L. Williams	7.30
2	Blue Room Engineering Society	W. D. Sprague	8.00
4	Amer. Soc. Hungarian Engrs. and Archts.	Z. deNemeth	8.30

Date	Society	Secretary	Time
December			
7–10	The American Society Mech. Engineers	Calvin W. Rice	
9	Illuminating Engineering Society	P. S. Millar	8.00
10	American Institute Electrical Engineers	R. W. Pope	8.00
14	American Society Engrg. Contractors	D. J. Haner	7.30
16	*American Institute Electrical Engineers	R. W. Pope	8.00
17	New York Railroad Club	H. D. Vought	8.15
21	New York Telephone Society	T. H. Lawrence	8.00
22	Municipal Engineers of New York	C. D. Pollock	8.15
January			
1	Amer. Soc. Hungarian Engrs. and Archts.	Z. deNemeth	8.30
5	Wireless Institute	S. L. Williams	7.30
6	Blue Room Engineering Society	W. D. Sprague	8.00
12	American Society Engrg. Contractors	D. J. Haner	7.30
13	Illuminating Engineering Society	P. S. Millar	8.00
14	American Institute Electrical Engineers	R. W. Pope	8.00
18–20	Amer. Soc. Heatng. and Ventilatng. Engrs.	W. M. Mackay	All day
18	New York Telephone Society	T. H. Lawrence	8.00
21	New York Railroad Club	H. D. Vought	8.15
26	Municipal Engineers of New York	C. D. Pollock	8.15

* Subject to change.

OFFICERS AND COUNCIL

PRESIDENT

JESSE M. SMITH..New York

VICE PRESIDENTS

L. P. BRECKENRIDGE..Urbana, Ill.
FRED J. MILLER..Center Bridge, Pa.
ARTHUR WEST..E. Pittsburg, Pa.

Terms expire at Annual Meeting of 1909

GEO. M. BOND..Hartford, Conn.
R. C. CARPENTER..Ithaca, N. Y.
F. M. WHYTE..New York

Terms expire at Annual Meeting of 1910

PAST PRESIDENTS

Members of the Council for 1909

AMBROSE SWASEY..Cleveland, O.
JOHN R. FREEMAN..Providence, R. I.
FREDERICK W. TAYLOR..Philadelphia, Pa.
F. R. HUTTON..New York
M. L. HOLMAN..St. Louis, Mo.

MANAGERS

G. M. BASFORD..New York
A. J. CALDWELL (Deceased)..Newburg, N. Y.
A. L. RIKER..Bridgeport, Conn.

Terms expire at Annual Meeting of 1909

WM. L. ABBOTT..Chicago, Ill.
ALEX. C. HUMPHREYS..New York
HENRY G. STOTT..New Rochelle, N. Y.

Terms expire at Annual Meeting of 1910

H. L. GANTT..New York
I. E. MOULTROP..Boston, Mass.
W. J. SANDO..Milwaukee, Wis.

Terms expire at Annual Meeting of 1911

TREASURER

WILLIAM H. WILEY..New York

CHAIRMAN OF THE FINANCE COMMITTEE

ARTHUR M. WAITT..New York

HONORARY SECRETARY

F. R. HUTTON..New York

SECRETARY

CALVIN W. RICE..29 West 39th Street, New York

EXECUTIVE COMMITTEE OF THE COUNCIL

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ALEX. C. HUMPHREYS FRED J. MILLER
F. M. WHYTE

STANDING COMMITTEES

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EDWARD F. SCHNUCK (2) ROBERT M. DIXON (4)
WALDO H. MARSHALL (5)

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HENRY S. LOUD (1), *Chairman* BERNARD V. SWENSON (3)
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H. H. SUPLEE (1) LEONARD WALDO (3)
CHAS. L. CLARKE (5)

MEETINGS

WILLIS E. HALL (1), *Chairman* L. R. POMEROY (3)
WM. H. BRYAN (2) CHARLES E. LUCKE (4)
H. DE B. PARSONS (5)

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HENRY D. HIBBARD (1), *Chairman* FRANCIS H. STILLMAN (3)
CHARLES R. RICHARDS (2) GEORGE J. FORAN (4)
HOSEA WEBSTER (5)

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ARTHUR L. WILLISTON (1), *Chairman* H. F. J. PORTER (3)
D. S. JACOBUS (2) H. W. SPANGLER (4)
GEO. I. ROCKWOOD (5)

RESEARCH

W. F. M. GOSS (5), *Chairman* R. C. CARPENTER (2)
JAS. CHRISTIE (1) R. H. RICE (3)
CHAS. B. DUDLEY (4)

NOTE.—Numbers in parentheses indicate length of term in years that the member has yet to serve.

SPECIAL COMMITTEES

1909

On a Standard Tonnage Basis for Refrigeration

D. S. Jacobus
A. P. Trautwein
G. T. Voorhees
Philip De C. Ball
E. F. Miller

On Society History

John E. Sweet
H. H. Suplee
Chas. Wallace Hunt

On Constitution and By-Laws

Chas. Wallace Hunt, *Chairman*
G. M. Basford
F. R. Hutton
D. S. Jacobus
Jesse M. Smith

On Conservation of Natural Resources

Geo. F. Swain, *Chairman*
Charles Whiting Baker
L. D. Burlingame
M. L. Holman
Calvin W. Rice

On International Standard for Pipe Threads

E. M. Herr, *Chairman*
William J. Baldwin
Geo. M. Bond
Stanley G. Flagg, Jr.

On Thurston Memorial

Alex. C. Humphreys, *Chairman*
R. C. Carpenter
Chas. Wallace Hunt
J. W. Lieb, Jr.
Fred J. Miller

On Standards for Involute Gears

Wilfred Lewis, *Chairman*
Hugo Bilgram
E. R. Fellows
C. R. Gabriel
Gaetano Lanza

On Power Tests

D. S. Jacobus, *Chairman*
Edward T. Adams
George H. Barrus
L. P. Breckenridge
William Kent
Charles E. Lucke
Edward F. Miller
Arthur West
Albert C. Wood

On Land and Building Fund

Fred J. Miller, *Chairman*
James M. Dodge
R. C. McKinney

On Student Branches

F. R. Hutton, Honorary Secretary

SOCIETY REPRESENTATIVES

1909

On John Fritz Medal

HENRY R. TOWNE (1)
AMBROSE SWASEY (2)
F. R. HUTTON (3)
CHAS. WALLACE HUNT (4)

On Board of Trustees United Engineering Societies Building

CHAS. WALLACE HUNT (1)
F. R. HUTTON (2)
FRED J. MILLER (3)

On Library Conference Committee

J. W. LIEB JR., CHAIRMAN OF THE LIBRARY COMMITTEE OF THE AM. SOC. M. E.

On National Fire Protection Association

JOHN R. FREEMAN
IRA H. WOOLSON

On Joint Committee on Engineering Education

ALEX. C. HUMPHREYS
F. W. TAYLOR

On Government Advisory Board on Fuels and Structural Materials

GEO. H. BARRUS
P. W. GATES
W. F. M. GOSS

On Advisory Board National Conservation Commission

GEO. F. SWAIN
JOHN R. FREEMAN
CHAS. T. MAIN

On Council of American Association for the Advancement of Science

ALEX. C. HUMPHREYS
FRED J. MILLER

NOTE.—Numbers in parentheses indicate length of term in years that the member has yet to serve.

OFFICERS OF THE GAS POWER SECTION
1909

CHAIRMAN
F. R. Low

SECRETARY
Geo. A. Orrok

GAS POWER EXECUTIVE COMMITTEE

F. H. Stillman, *Chairman*
G. I. Rockwood
F. R. Hutton
H. H. Suplee
R. H. Fernald

GAS POWER MEMBERSHIP COMMITTEE

Robert T. Lozier, *Chairman*
D. B. Rushmore
Albert A. Cary
A. F. Stillman
H. V. O. Coes
G. M. S. Tait
A. E. Johnson
George W. Whyte
F. S. King
S. S. Wyer

GAS POWER MEETINGS COMMITTEE

Cecil P. Poole, *Chairman*
E. S. McClelland
R. T. Kent
C. T. Wilkinson
C. W. Obert

GAS POWER LITERATURE COMMITTEE

C. H. Benjamin, *Chairman*
L. S. Marks
H. R. Cobleigh
T. M. Phetteplace
G. D. Conlee
G. J. Rathbun
R. S. de Mitkiewicz
W. Rautenstrauch
L. V. Goebbels
S. A. Reeve
L. N. Ludy
A. J. Wood
A. L. Rice

GAS POWER INSTALLATIONS COMMITTEE

J. R. Bibbins, *Chairman*
A. Bement
L. B. Lent

GAS POWER PLANT OPERATIONS COMMITTEE

I. E. Moultrop, *Chairman*
H. J. K. Freyn
C. H. Parker
J. D. Andrew
N. T. Harrington
J. P. Sparrow
W. H. Blauvelt
J. B. Klumpp
A. B. Steen
V. Z. Caracristi
G. L. Knight
F. W. Walker
E. P. Coleman
J. L. Lyon
C. W. Whiting
C. J. Davidson
D. T. MacLeod
Paul Winsor
W. T. Donnelly
V. E. McMullen
T. H. Yawger

GAS POWER STANDARDIZATION COMMITTEE

C. E. Lucke, *Chairman*
E. T. Adams
Arthur West
James D. Andrew
J. R. Bibbins
H. F. Smith
Louis C. Doelling

OFFICERS OF STUDENT BRANCHES

STUDENT BRANCH	AUTHORIZED BY COUNCIL	HONORARY CHAIRMAN	PRESIDENT	SECRETARY
	1908			
Stevens Inst. of Tech., Hoboken, N. J.	December 4	Alex. C. Humphreys	H. H. Haynes	R. H. Upson
Cornell University, Ithaca, N. Y.	December 4	R. C. Carpenter		C. F. Hirshfeld
	1909			
Armour Inst. of Tech., Chicago, Ill.	March 9	C. F. Gebhardt	N. J. Boughton	M. C. Shedd
Leland Stanford, Jr. University, Palo Alto, Cal.	March 9	W. F. Durand	P. H. Van Etten	H. L. Hess
Polytechnic Institute, Brooklyn, N. Y.	March 9	W. D. Ennis	J. S. Kerins	Percy Gianella
State Agri. College of Oregon, Corvallis, Ore.	March 9	Thos. M. Gardner	C. L. Knopf	S. H. Graf
Purdue University, Lafayette, Ind.	March 9	L. V. Ludy	E. A. Kirk	J. R. Jackson
Univ. of Kansas, Lawrence, Kan.	March 9	P. F. Walker	H. S. Coleman	John Garver
New York Univ., New York	November 9	C. E. Houghton	Harry Anderson	Andrew Hamilton
Univ. of Illinois, Urbana, Ill.	November 9	W. F. M. Goss	W. F. Colman	S. G. Wood
Penna. State College, State College, Pa.	November 9			
Columbia University, New York	November 9			
Mass. Inst. of Tech., Boston, Mass.	November 9		Fredk. A. Dewey	
Univ. of Cincinnati, Cincinnati, O.	November 9			
Univ. of Wisconsin, Madison, Wis.	November 9			

THE JOURNAL

OF

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

VOL. 31 SEPTEMBER 1909 NUMBER 7

MONTHLY meetings of the Society are to be held in New York on the evenings of October 12 and November 9. The Annual New York Meeting will be held December 7–10. The importance and interesting character of papers on hand and in preparation assure professional sessions for these meetings of the greatest possible value to the membership and indicate an even larger attendance than in preceding years. As announced elsewhere in this number in the reports of the meetings of the Society held early in the summer in Boston and St. Louis, arrangements are well advanced for meetings in these cities throughout the fall and winter. The subjects for several of the Boston meetings have already been tentatively announced in the report referred to and papers are promised which should add materially to the value of the publications of the Society.

HUDSON-FULTON CELEBRATION

In connection with the Hudson-Fulton Celebration in September and October, in New York, and as a contribution on the part of the engineering profession, there will be placed in the rooms of The American Society of Mechanical Engineers, on the eleventh floor of the Engineering Building, a valuable exhibit of objects of interest relating to the early history of steam navigation. This exhibit is being prepared by a sub-committee of the House Committee of the Society, in accordance with action of the Executive Committee of the Council, taken in response to an invitation received January

7, from the Historical Exhibit Committee of the Hudson-Fulton Celebration Commission.

A room of the Society will be set apart early in September for the exhibit. It will be open to the public every week-day from nine to five.

The exhibit will include the following material belonging to the Society: oil portrait of Robert Fulton by himself; original drawing of the Clermont by Robert Fulton and signed by him March 1, 1813; solid mahogany table formerly belonging to Robert Fulton; autograph brush drawing by Robert Fulton, 1797, illustrating an aqueduct for a high level canal; reproduction in bronze of the Fulton drawing of the Steamer Potomac, 1820, prepared by the Society; letters of Fulton's workmen concerning the first steamboat; photograph of West portrait of Fulton; portraits of naval and marine engineers, as Haswell, Loring, Thurston, Melville, See, Worthington, Ericsson, Watt, Holley, Stillman, etc.

The Society has secured for the exhibit from the United Engineering Society, the Ericsson models; and from the Smithsonian Institution, the models of Fulton's Clermont, John Fitch's steamboat, and John Stevens' Phoenix.

Any members having models or relics of interest in connection with the celebration are requested to communicate with E. Van Winkle, Chairman of the sub-committee, 90 West St., New York.

The special committee on Hudson-Fulton Celebration is as follows: Rear-Admiral George W. Melville, Ret., Past-President, Am.Soc.M.E.; M. L. Holman, Past-President, Am.Soc.M.E.; Jesse M. Smith, President, Am.Soc.M.E.

MEETING OF THE COUNCIL

At the meeting of the council June 2, 1909, there were present: Jesse M. Smith, President, presiding, and Messrs. Bond, Carpenter, Miller, Riker, Swasey, Stott, Oberlin Smith, Whyte, A. M. Waitt and the Secretary. Letters of regret were received from Messrs. Humphreys and Moultrop.

Announcement was made of the deaths of A. J. Caldwell, Manager, A. W. K. Peirce, and Alex. Miller. The resignation of Charles W. Kettell was accepted.

Voted: To approve the following appointments by the President of Honorary Vice-Presidents: Jesse M. Smith to represent the Society at the Commencement exercises of Columbia University; Calvin W.

Rice and Worcester R. Warner to represent the Society at the Inauguration of Richard Cockburn MacLaurin as President of Massachusetts Institute of Technology.

Voted: To authorize the Finance Committee at its discretion to appropriate $300 for the work of the Committee on Power Tests.

Voted: To refer to the Committee on History the communications received from John E. Sweet and Ambrose Swasey with respect to organization members of the Society.

Voted: That a committee of three be appointed by the President to consider the communications from the Association of Steel Manufacturers, under dates of January 13 and February 2, and report to the Council.

Voted: To approve the recommendation of the Executive Committee with respect to the appointment of Dr. Charles B. Dudley, as Honorary Vice-President, to represent the Society at the Congress of the International Association for Testing Materials, to be held in Copenhagen, Sweden, September 7 to 11, 1909.

Voted: To approve the action of the Meetings Committee, declining the petition for a National Conference on the subject of Smoke Abatement.

Voted: That the Council suggest to the Meetings Committee that it may arrange for a monthly meeting in the near future on the subject of Smoke Abatement on strictly engineering lines.

Voted: That the Executive Committee be given entire charge of the arrangements for a joint meeting of the Society with the Institution of Mechanical Engineers in England, during 1910, at such time and place as may be selected by the Institution.

Amendments: Upon the recommendation of the Committee on Constitution and By-Laws, the following amendments were adopted:

B 17 A ballot which contains more unerased names than there are officers to be elected is thereby defective and shall be rejected by the tellers.

R 30 The American Society of Mechanical Engineers will furnish monthly issues of The Journal to all members of affiliated organizations who are not members of The American Society of Mecanical Engineers upon the payment by each of two dollars per year. The American Society of Mechanical Engineers will also furnish to the secretary of each affiliated body, a certain number of extra copies of advance papers for use at its meetings, the number furnished to be agreed upon in each case.

R 4 Each paper which has been accepted by the Committee on Meetings for presentation at any meeting of the Society shall be published in The Journal at least seven days in advance of that meeting and in the form in which has been accepted by that committee, and that paper shall also be distributed in pamphlet form at that meeting. A paper received too late for such distribution shall only

be accepted for presentation at that meeting by unanimous consent of the Committee on Meetings. A member may by letter signify his intention to discuss any of the papers and unless otherwise directed by the presiding officer priority in debate shall be given in the order of the receipt by the Secretary of such notification.

Voted: To add to the Rules the following and refer back to the committee for consideration under C 47:

R 2 The Council shall, previous to January first of each year, elect a Trustee to serve for three years on the Board of Trustees of United Engineering Society.

Voted: To rescind the action of the Council of January 31, 1905 authorizing rules for the organization and conduct of geographical sections, given in Transactions of the Society, Vol. 27, pages 39 and 40.

It was further voted to approve the recommendations of the Committee regarding C 10 and C 11.

On motion the meeting adjourned.

SECTIONS AND BRANCHES

WORK OF THE GAS-POWER SECTION

During the summer the work of the Gas-Power Section has been actively carried on. The Installations Committee has collected data for presentation at one of the meetings of the section. The Plant Operations Committee has several installations under observation from which information is being obtained.

The Membership Committee reports that the membership of the section is above 330 and many of the applicants for membership in the section have also applied for membership in the Society.

The work in the smaller cities throughout the United States is thoroughly organized and the results of these efforts are becoming apparent. The committee is gratified at the many requests received for information. The Literature Committee has reviews and indexes of articles and publications in preparation, which will soon be available to those seeking information.

At the meeting of the Gas Power Executive Committee early in July, in accordance with a request from several colleges, an Advisory Research Committee was appointed to assist the Executive Committee in preparing a plan of work which should avoid as far as possible unnecessary duplications and produce the best results in the solution of the various problems now open. This committee includes the following: R. H. Fernald, C. P. Breckenridge, R. C. Carpenter, W. T. Magruder, W. D. Ennis, C. E. Lucke, L. S. Marks, H. N. Davis, D. L. Gallup, W. H. Kavanaugh.

A list of important problems, the solution of which is greatly needed, is being prepared and it is expected that the results obtained by the help of this list will be of great value. The Meetings Committee has been promised four valuable papers for the coming season and several others are in prospect for later delivery.

ACTIVITIES OF THE BROOKLYN POLYTECHNIC STUDENT SECTION

The Student Section of the Society at the Brooklyn Polytechnic Institute held a meeting on May 1, which was addressed by Prof. Wm. D. Ennis, Mem.Am.Soc.M.E., professor of mechanical engineering of the Institute. The subject of his address was The Manufacture of Vegetable Oils. At the meeting of June 5, James A. Nelson delivered an illustrated lecture on Hydraulic Machinery. The program committee reported that meetings of similar value are outlined for the coming year.

LECTURES BEFORE THE STEVENS ENGINEERING SOCIETY

The Stevens Engineering Society, affiliated with The American Society of Mechanical Engineers, has arranged for a number of lectures during the coming college year at Stevens Institute of Technology. As will be seen from the following list, the speakers are men high in their profession and the topics cover a wide range: F. A. Waldron, Mem.Am.Soc.M.E., "The Commercial Value of a Specialist;" Fred. W. Taylor, Mem.Am.Soc.M.E., "Success;" Prof. F. R. Hutton, Hon. Secy., Am.Soc.M.E., "The Problems of the Large Gas Engines;" Prof. H. C. Sadler, on some branch of naval architecture; Prof. D. C. Jackson, Mem.Am.Soc.M.E., "Engineering Education;" Chas. W. Baker, Mem.Am.Soc.M.E., "The Panama Canal;" H. G. Stott, Mem.Am.Soc.M.E., subject to be announced; Rear Admiral Melville, Mem.Am.Soc.M.E., "The Essentials of Naval Efficiency in an Age of Engineering;" C. de Zafra, "Explosives;" Hudson Maxim, "The Warfare of the Future;" T. C. Martin, subject to be announced; Samuel Whinery, Mem.Am.Soc.M.E., "Street Pavements and Road Construction;" H. L. Gantt, Mem.Am.Soc.M.E., "Industrial Management;" Professors G. V. Wendell and L. A. Martin, "The Gyroscope;" Frank B. Gilbreth, Mem.Am.Soc.M.E., "Methods and System in Relation to Handling Concrete Work;" Prof. J. C. Ostrup, "Notable Examples in Modern Construction;" Naval Constructor D. W. Taylor, "The Development of the New Navy;" Prof. C. F. Kroeh, subject to be announced; J. A. Brashear, Hon.Mem.Am.Soc. M.E., "The Contributions of Photography to Our Knowledge of the Stellar Universe."

MEETINGS IN BOSTON AND ST. LOUIS

MEETING OF THE SOCIETY AT ST. LOUIS

A meeting was held at the Missouri Athletic Club, St. Louis, Mo., on May 15 to discuss the question of holding meetings of the Society. William H. Bryan, member of the Meetings Committee, presided, Prof. E. L. Ohle acting as secretary.

The report of the committee on organization was first presented, the committee recommending that the Society coöperate with the Engineers' Club of St. Louis in the matter of meetings and publications.

In opening the discussion, M. L. Holman, Past President Am. Soc.M.E., said that the question of enlarging the sphere of usefulness of national engineering societies without interfering with local organizations, many of which antedate the national organizations, is one which has been given much thought by the engineers of the country. The St. Louis Engineers' Club is an earlier organization than The American Society of Mechanical Engineers. It has taken some years to bring it up to its present standing; it has a good record and a strong organization. The engineers of St. Louis could not afford to take any steps that would interfere in any way with the usefulness of the club or in any way impede its growth and importance.

The movement under consideration, however, was not to antagonize local engineering clubs, but was intended to help them in every way practicable. The movement was for the purpose of bringing more engineers into the societies, both local and national, and any work that could be done to accomplish this result would be for the benefit of both the local and the national organization. The members of the Society had started the movement in Boston and were working in sympathy with the Boston Society of Civil Engineers. He could only express his approval of the work done in St. Louis in harmony with the Engineers' Club of that city. In conclusion, Mr. Holman moved the adoption of the report.

R. H. Tait expressed himself as heartily in accord with the monthly meetings in St. Louis. Wm. H. Bixby felt that the Society as a

national society should have local meetings in different cities, but the difficulty would be to make these national in character, with the papers fully and freely discussed.

In answer to a question by Prof. H. Wade Hibbard as to the attitude of the members of the Engineers' Club toward the coöperative movement, Wm. H. Byran said that four ex-presidents of the club had obtained the views of club members and as far as could be learned they were in favor of the movement. He could imagine no grounds for objection. All responsibility and, at present, all expenses were assumed by the Society. The Society proposed to join in the responsibility of maintaining the mechanical engineering division of the club's work, which, to the speaker, seemed a proposition that the club would readily accept. Mr. Bryan said further that the plan for organization would be submitted to the New York office of the Society for approval and, granting favorable action, would then be submitted to the Engineers' Club.

With regard to the question of a meeting night Mr. Bryan thought it might be the night following the meeting of the St. Louis Railway Club, held on the second Friday of each month. If a local meeting of the Society were held on the Saturday evening following, a number of mechanical engineers and master mechanics would stay over Friday and attend the meeting. It was not proposed to take one of the two regular meeting nights of the Engineers' Club, though this might be done occasionally.

There was no question, said Thomas Appleton,that the holding of local meetings would be to the advantage of each local member as well as to the national Society. The movement had been started in the right way.

Professor Westcott, though not a member, pledged his support for the meetings. The success of the movement would mean much to those outside of St. Louis, as it would afford them an opportunity to meet the leading engineers of that vicinity.

The holding of local meetings, said F. L. Jefferies, would in no way interfere with the growth or strength of city clubs, as members of the Society would become better acquainted with engineers of that section and would be more likely to join city clubs. Neither would there be any likelihood of the members resigning from the Society to join local clubs, as the Society membership would be of value to them whether they remained in that city or went elsewhere.

W. M. Armstrong expressed some doubt as to the possibility of

obtaining papers of national interest at each meeting. He thought that the discussions might prove of local interest only.

While the difficulty of obtaining monthly papers up to the full Society standard was realized, said Mr. Bryan, the discussions could be much less formal in character, the Society exercising its judgment as to what part, if any, would be published.

The question of publication, Mr. Holman pointed out, was fully settled by issuing the monthly Journal and the yearly Transactions. Papers on subjects that are developing, and those that, while interesting and instructive, are not monumental, are published in The Journal with the other proceedings of the Society. Papers of high quality pass through The Journal as a sieve and are then published in the Transactions. A report of any meeting would appear in The Journal, but only contributions to permanent literature would be accepted for the Transactions.

Both Mr. Bryan and Professor Hibbard spoke on the desirability of not anticipating difficulties but of solving each problem as it was presented. The latter speaker was hopeful for the development of the talent among mechanical engineers which the proposed meetings would bring about. He felt that in approaching the questions which would come up they should proceed as well as possible, inspired with the knowledge that their growth would produce papers and discussions of value to the profession throughout the country.

J. A. Laird expressed his approval of the report of the committee. The scheme outlined would be in no way a detriment to the Engineers' Club of St. Louis. He would be opposed to any local organization that would detract from the Engineers' Club, but he believed that the proposed plan would help the club by creating an interest in mechanical engineering papers and the discussion on them. The presentation of papers in connection with the club meetings he believed would add to the interest of the meetings and increase the club's membership.

Victor Hugo thought that St. Louis should be represented in the Society in the manner proposed, and local engineers should avail themselves of the opportunity for initiating the movement.

E. A. Fessenden, speaking as one of the younger members, said that while he considered The Journal and the Transactions valuable, the associations which Society membership made possible were more so. The St. Louis meetings would enable the younger members to come into personal touch with older and more experienced engineers and would convert into live, active members those who felt that membership in the Society was largely nominal.

Following Mr. Fessenden, the adoption of the report was then considered, the vote being unanimously in its favor. A motion to continue Mr. Bryan as chairman and Professor Ohle as secretary was also adopted. The thanks of the meeting were also voted to the chairman and to those assisting him in the work of organizing.

The chairman then called on Prof. F. H. Vose, the only local member of the Society who had attended the Washington convention, to make a brief report of the proceedings at the convention.

While it was his first experience at a meeting of the national Society, Professor Vose said he was distinctly impressed with the fact that the Society was by no means a New York organization. He met men from all over the country and they seemed to have their share in the management of affairs. He did not believe that they were trying to fix the character of the local meetings at St. Louis but rather that they earnestly desired to place these meetings on the same footing as those held monthly in New York.

Professor Vose then gave an interesting running account of the papers and discussion presented at Washington.

BOSTON MEETING, JUNE 11

Following the plan of holding meetings of the Society in cities other than New York, inaugurated at the meeting of the Society in Boston on April 16, details of which were given in the June issue of The Journal, a meeting was held there on June 11, at which Geo. A. Orrok's paper on "Small Steam Turbines" was presented for discussion.

Prof. Ira N. Hollis, who presided, first outlined the work proposed for the meetings of the Society in Boston saying that the committee was planning a number of meetings after October 1 and was endeavoring to obtain papers in season for publication in The Journal. In order to show what preparation had been made Professor Hollis read the following list of subjects, papers on which had been promised or which it was hoped to obtain:

"A Comparison of the Different Methods of Figuring the Strength and Stiffness of Reinforced-Concrete Beams."

"Cooling Towers and Spraying Nozzles for Cooling Towers."

"The Action of Superheated Steam on Different Metals."

"Friction Loss in Turbine Nozzles."

"The Effect of Bleeding Steam from Turbines for Manufacturing Purposes."

"Air Pumps and Condensers."

It was also desired to obtain a list of all engineers interested in the meetings. Notices had been sent to 950 engineers in the vicinity of Boston. Of that number 340 were members of the Society, so that a substantial number were available as a neucleus. Professor Hollis then called on Secretary Calvin W. Rice to address the meeting.

The meeting, said Mr. Rice, was in every sense a meeting of the Society, just as though it were held in New York. He had been asked by the editor of a technical paper if it were allowable to publish the proceedings of the meeting and had replied that the Society desired that the widest publicity be given to all the proceedings. He had great appreciation for the work of the committee in making the meetings possible and further he emphasized that the present meeting was an official one and the members had the right to expect the presence and assistance of the officers of the Society.

Mr. Rice expressed pleasure at the possibility of a joint meeting with the Boston Society of Civil Engineers as it was the desire of The American Society of Mechanical Engineers to unify and bring together all engineers and not to establish additional societies.

Professor Hollis then asked Prof. E. F. Miller to read Mr. Orrok's paper, after which the meeting was given over to discussion.

GENERAL NOTES

GIFT TO LEHIGH UNIVERSITY

John Fritz, Past-President and Hon.Mem.Am.Soc.M.E., has given $50,000 to Lehigh University for an engineering laboratory. Mr. Fritz has been a trustee of the university for over thirty years. The Board of Trustees has appropriately recognized this gift by naming it the John Fritz Engineering Laboratory.

SORBONNE MEDAL PRESENTED TO ANDREW CARNEGIE

A medal was presented to Andrew Carnegie, Hon.Mem.Am.Soc. M.E., by the Council of the Sorbonne, Paris, on May 26, in recognition of his founding of the Curie scholarship in 1906. The guests of the occasion, in addition to the entire faculty of the college, were Madame Curie, Ambassador White, Baron D'Estournelles de Constant and M. Niet, President of the French Salon.

CONTRIBUTION TO THE CONGRESSIONAL RECORD

The article on The Lock Canal at Panama contributed to the May number of the Outlook by John R. Freeman, Past-President Am. Soc.M.E., and member of the special board appointed to investigate the Gatun Dam, together with an editorial article by Charles Whiting Baker, Mem.Am.Soc.M.E., and Editor of the Engineering News, was presented before the House by Hon. Wm. H. Wiley, Treasurer, Am.Soc.M.E., and was ordered published in the records of that body.

UNIVERSITY OF ILLINOIS DINNER TO PROFESSOR BRECKENRIDGE

Prof. L. P. Breckenridge, who recently resigned from the department of mechanical engineering of the University of Illinois, to take up his work as director of the same department of the Sheffield Scientific School at Yale University, was tendered a farewell dinner on the evening of June 21, by the engineering alumni of the university from Chicago and vicinity. Professor Breckenridge spoke

of his new work and also of the keen interest which he would always have in his former connections.

PORTRAIT OF PROF. CHARLES B. RICHARDS

The portrait of Prof. Charles B. Richards, Mem.Am.Soc.M.E., was recently painted by Emil Fuchs, for presentation to Sheffield Scientific School of Yale University by a committee composed of Professor Richards' former pupils. Professor Richards, who was one of the organization members of The American Society of Mechanical Engineers, is retiring from his position as head of the department of mechanical engineering of Sheffield Scientific School after a quarter of a century of continuous service.

FIRST NATIONAL CONSERVATION CONGRESS

The First National Conservation Congress of the United States of America, composed of representatives from each of the important industries and callings throughout the country, convened August 26–28 in the auditorium of the Alaska-Yukon-Pacific Exposition at Seattle, Wash. This is the first general convention covering the conservation and utilization of all related and interdependent resources of the nation, although there have been important general meetings devoted to one or two special branches of this movement. The Congress was held under the auspices of the Washington Conservation Association, with the approval of conservation commissions and committees of states and of the joint committee on conservation between states and nations, and had among its speakers men of international eminence. Members appointed to represent the Society at the Congress were: Robert M. Dyer, Myron Knox Rogers, Wm. F. Zimmermann.

AVERY ENGINE PRESENTED TO THE SOCIETY

Prof. John E. Sweet, Past-President and Hon.Mem.Am.Soc. M.E., and a nephew of William Avery, the inventor, has presented to the Society the rotor of one of the original engines built in Mr. Avery's shop in Syracuse, N. Y., sometime between 1835 and 1840. The Avery engine was a rotary engine, or turbine of the reaction type, having a hollow forged rotor in the form of two diametrically opposite arms. The arms were hung on a hollow shaft through which the steam entered, passing through the hollow arms and escaping through orifices at their ends.

In a description of the engine Prof. Sweet states that the shaft had no metal bearings except at the extreme outer end and beyond the driving pulley; at the end of the shaft opposite the steam pipe, where the steam entered the hollow shaft, rollers were placed to take the pressure of the steam, usually 150 lb. The metal bearing referred to was in connection with these rollers. On each side of the case in which the arms revolved was a packing box in which hemp packing was used. These two packing boxes made the main bearings of the engine.

A Mr. Herrick, who helped build and operate the engines, said that when slide-valve engines were substituted for Avery engines no gain was made in steam economy. Trouble was had with the packing and with the cutting out of the blades at the ends of the arms. Mr. Avery refers in his notebook to a rotor 7 ft. long which ran 14¼ miles a minute.

DEDICATION OF RUSSELL SAGE LABORATORY AT RENSSELAER POLYTECHNIC INSTITUTE

The new building for the School of Mechanical and Electrical Engineering, erected through the generosity of Mrs. Russell Sage, was formally opened on June 15, in the presence of a large gathering of alumni and well-known engineers. Addresses were made bv Robert W. DeForest, of New York, Mrs. Sage's attorney and representative, by Jesse M. Smith, Pres.Am.Soc.M.E., and an alumnus, and by Lewis B. Stilwell, Pres.Am.Inst.E.E.

President Smith said in part: Rensselaer Polytechnic Institute has a higher destiny than the education of men in a single branch of engineering, and in this eighty-fifth year of its growth mechanical engineering has finally been recognized. No engineering work of importance can progress far without it and engineering has taken such an important part in the activities of this country that no industry can attain prominence unless it be entrusted principally to engineers. An engineer who does not look beyond his own circumscribed horizon cannot become great, for the fields covered by the various branches of his profession overlap one another and new conditions constantly arise so that he cannot tell what he will be called upon to do next. The establishment of courses of mechanical and electrical engineering in addition to civil engineering simply means that the trustees and faculty of Rensselaer have recognized the demand for a higher and broader education. It is possible that in the future

each graduate of an engineering school will receive the same general degree and that after years of practice he may return to the Institute and be examined for a degree in his chosen specialty. I hold for the highest possible school education for the engineer without regard to specialty.

The Institute now possesses three splendidly equipped new buildings erected within the last four years. Of the Sage gift of $1,000,000 the sum of $700,000 has been reserved for a permanent endowment fund.

The Society was further represented at the dedication by Charles Whiting Baker, Editor of Engineering News, Profs. Wm. H. Burr and Fredk. A. Goetze of Columbia University, Prof. H. W. Spangler of the University of Pennsylvania, and Wm. B. Cogswell, of Syracuse.

INAUGURATION OF PRESIDENT MACLAURIN

Richard Cockburn MacLaurin, formerly associated in educational work in England and Australia and later professor of mathematical physics at Columbia University, was inaugurated President of the Massachusetts Institute of Technology on June 7. On the platform were representatives of almost every department of educational and scientific activity, including college presidents from all parts of the United States and members of scientific associations and technological institutions. In accordance with a vote of the Council, the Society was represented by Worcester R. Warner, Past-President and Calvin W. Rice, Secretary and graduate of the Institute.

Among the speakers were Frederick P. Fish, a member of the executive committee of the corporation, who announced the election of Professor MacLaurin as president of the Institute; Governor Eben S. Draper of Massachusetts, a graduate of Massachusetts Institute of Technology; ex-president Pritchett, now president of the Carnegie Foundation for the Advancement of Teaching; James P. Munroe, former president of the Alumni Association of the Institute; President A. Lawrence Lowell of Harvard University; The Right Honorable James Bryce, ambassador from Great Britain; and Dr. Arthur A. Noyes, chairman of the faculty.

In his inaugural address, President MacLaurin outlined his creed as an educator. He said in part: The end of education is to fit men to deal honestly, intelligently and efficiently with the affairs of a life as abundant and complete as possible. Science should play a very prominent if not a leading part in the higher education of an increas-

ing section of the community, since the great problems of a nation today are mainly scientific, and the quickness with which the different nations have grasped the fact that energy, courage and doggedness are no longer enough to win the fight, might be used as a touchstone of their intelligence. Science and culture must be combined. The root of culture is the possession of an ideal broad enough to form the basis of a sane criticism of life, and technical schools should not only train men for those professions in which science plays a leading part but should in addition fit them to extend the bounds of knowledge in as many directions as they see opportunity. Above all, the freshness and vigor of youth must be preserved in our students and their natural powers of initiative improved outside the classroom by a rational system of athletics and a rational social life.

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS

Dr. Charles B. Dudley, Mem.Am.Soc.M.E., has been appointed delegate on the part of the United States to the Congress of the International Association for Testing Materials to he held at Copenhagen, September 7–11, 1909. Dr. Dudley will also act as official delegate of this Society to the Congress.

OTHER SOCIETIES

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

The twenty-sixth annual convention of the American Institute of Electrical Engineers was held at Frontenac, N. Y., June 28–July 1. The registration reached a total of 286.

Among the papers presented were: Alternator for 100,000 Cycles, Multispeed Induction Motors, Alternating-Current Motors versus Direct-Current Motors in Steel Mills, Power Requirements for Rolling High-Carbon Steel of Small Section, Electrical Control for Rolling-Mill Motors, The Training of Non-Technical Men.

The Society was represented at the convention by J. W. Lieb, Jr., S. Hosmer, Paul M. Lincoln, Prof. Morgan Brooks, D. B. Rushmore, W. G. Carleton, C. W. Stone, Earl Wheeler, W. N. Ryerson, H. G. Reist, A. H. Kruesi, W. I. Slichter, and others.

AMERICAN SOCIETY OF CIVIL ENGINEERS

The annual convention of the American Society of Civil Engineers was held July 6–9, at Mt. Washington Hotel, Bretton Woods, N. H. The presidential address was delivered at the opening session by Onward Bates, on The Status of the Civil Engineer's Profession in the United States. Two reports were discussed, one on the Status of the Metric System, the other that of the Special Committee on Concrete and Reinforced Concrete. Among the papers presented were: Fire Resistant Construction in Buildings, by Herbert M. Wilson; Impurities in Sand for Concrete, by S. E. Thompson; and Road Watering as Compared with Oiling for Laying Dust, by Saml. Whinery, Mem.Am.Soc.M.E.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS

A new national society, the American Institute of Chemical Engineers, held its first meeting in the Brooklyn Polytechnic Institute, New York, June 24–26. During the first day papers were presented on the following subjects: The Limits of Efficiency of the Power Gas Producer, Prof. W. D. Ennis, Mem.Am.Soc.M.E.; The Utilization of Low-Grade Fuels in the United States, O. K. Zwingenberger;

Creosote Oil from Water Gas Tar, S. P. Sadtler; The Centering of Great Industries in the Metropolitan District, Dr. C. F. McKenna; Experiments in the Case-Hardening of Steel with Gases, Prof. J. C. Olsen; Methods of Clay Control, J. G. Dean. The remaining days of the convention were spent in trips to plants of interest, such as the Atlantic Lead Works in Brooklyn and the Standard Oil Company's works in Bayonne, N. J.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS

The summer meeting of the Society of Naval Architects and Marine Engineers was held at Detroit, Mich., June 24–26. Papers were presented on Some Model Experiments on Suction of Vessels; A Method of Determining Pressures in Steam Turbines; The Resistance of Some Full Types of Vessels; The U. S. S. Michigan, renamed the Wolverine; Shallow Draft-Steamers; Material Handling Arrangement for Vessels on the Great Lakes; The Strength of Knees and Brackets on Beams and Stiffeners; and Towing Problems. The Society was represented at the meeting by T. H. Hinchman, Jr., Alex Dow, W. J. Keep and Walter S. Russel, of Detroit, and Prof. M. E. Cooley, of Ann Arbor, Mich.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION

The Society for the Promotion of Engineering Education held its annual convention in New York, June 24–26, meeting for its several sessions in the Engineering Societies Building, at Columbia University and at Pratt Institute. Papers were presented by Prof. F. E. Turneaure on Present Tendencies in Technical Education; by Charles Buxton Going on The Relation of Engineering Education to Industry; by Fred. W. Taylor, Mem.Am.Soc.M.E., on The Preparation of Technical Graduates for Industries; and by Prof. Hugo Diemer, Mem.Am.Soc.M.E., on Employers' Requisites of Technical Graduates.

NATIONAL ASSOCIATION OF GERMAN-AMERICAN TECHNOLOGISTS

The silver anniversary of the founding of the National Association of German-American Technologists was celebrated in Philadelphia, Pa., August 28–31. In addition to the sessions of delegates, trips were made to various points of engineering importance in and about the city. G. A. Stierling delivered a lecture before the association on Reinforced Concrete.

NECROLOGY

EDWIN REYNOLDS

Past-President, Am.Soc.M.E.

Edwin Reynolds was born in Mansfield, Conn., March 23, 1831, and was apprenticed at the age of 16 to A. P. Kenney, a local machinist. At the end of three years' apprenticeship he started on a journeyman's tour of various shops in lower New England.

About 1857 Mr. Reynolds went West and for a time was superintendent of the shops of Steadman & Co., of Aurora, Ill., builders of engines, sawmill machinery, drainage pumps, etc., for the Southern trade. As this business practically ceased during the Civil War, he returned to the East and was employed in several machine works until, in 1867, having attracted the attention of George H. Corliss, he was offered a position in the works of the Corliss Steam Engine Company, at Providence, R. I., where he remained as general superintendent until 1877. His last notable work with the Corliss company was the design of a rolling-mill engine to run at 160 r.p.m. a speed double that of previous designs. This engine was installed at the works of the Trenton Iron Co., in 1877. In 1890 a second flywheel was added and the speed increased to 180 r.p.m.

In 1877 Mr. Reynolds accepted the position of general superintendent of the Edward P. Allis Company, of Milwaukee, Wis., his first work being to place the company on a paying basis, largely through the development of the Reynolds-Corliss engine. He later developed the building of a varied line of machinery, including large Corliss-engine units for pumping service, mining, air compressing, furnace blast, street-railway work and other purposes. One noteworthy achievement was the building, in 1888, of the first triple-expansion pumping engine for waterworks service. This engine was described by Professor Thurston as "doing continuously so high a duty as to place it among the most remarkable constructions of its class and time, and probably to make its record the highest to date (1894)."

The blowing engine designed by Mr. Reynolds for the original Joliet Steel Company and chosen from among competitive designs

submitted by leading engineers in the United States and Europe, embodied a radical departure from accepted practice, but after more than 25 years of continuous experimenting the essential features of this design have not been improved upon.

The well-known story of his sketching the design of the horizontal-vertical four-cylinder compound engine for the Manhattan Railway Company's power house in New York City, while on the train from Milwaukee to New York, illustrates his marvelously quick inventive genius.

At the time of his death, Mr. Reynolds was consulting engineer of the Allis-Chalmers Company, although the illness of the past three years had prevented active duty. He took a great interest to the last in the magnificent new works of the company at West Allis, which had been laid out on a strictly engineering basis, after his plans, at the time the Edward P. Allis Company became merged in the new organization.

He was also interested in a number of other plants of Milwaukee and vicinity, had been the first president of the National Metal Trades Association, and bore the degree of LL.D., conferred upon him by the University of Wisconsin, on the wall of whose college of engineering his name has been carved.

Mr. Reynolds served as Vice-President of the Society from 1892–1894, and as President for the year 1902.

His death occurred at his home in Milwaukee February 19, 1909.

ANDREW JAMES CALDWELL

Andrew James Caldwell, Manager, Am.Soc.M.E., died in New York City, May 10, 1909. Mr. Caldwell was born in Brooklyn, N. Y., May 1, 1858, and was graduated from the University of Maine in 1878, with the degree of B.M.E. He also took a graduate course at Cornell University.

He first entered the employ of the Delamater Iron Works, and later that of one of the regular line steamship companies on the New York and New Orleans route. In 1880 he became connected as draftsman with the firm of Henry R. Worthington, and was closely identified with the designing and development of the Worthington high-duty pumping engine. He was soon made chief of the erecting and testing departments, which dealt with water-works pumping machinery; then assistant to the president, Charles C. Worthington; and finally general manager of the hydraulic works.

Soon after the formation of the International Steam Pump Company, he resigned to take a similar position with the Crane Company of Chicago, by which he was later sent to Bridgeport, Conn., to take charge of the new plant of the Eaton, Cole & Burnham Company, controlled by them. In 1902 he resigned, accepting a position with the National Foundry Association, and later entered the service of the Standard Oil Company, with which he was identified at the time of his death.

Mr. Caldwell was elected Manager of the Society in 1906, and was still serving at the time of his death. He was a member of the Engineers' Club in New York, and one of the organizers and first president of the Brooklyn Engineers' Club.

ALEXANDER MILLER

Alexander Miller, head of the firm of Alexander Miller and Brothers of Jersey City, N. J., died May 6, 1909, at his home in New York. Mr. Miller was born in Aberdeen in 1857 and came to this country at an early age. He began his engineering career at the old Delamater Iron Works of New York, of which his father was superintendent. Later he formed a connection with the Deeley Iron Works and specialized in sugar-evaporating machinery. More recently he applied with conspicuous success the experience thus gained to the problem of the evaporation of brine in the manufacture of salt. Three of the New York fire boats were also the product of his works.

Mr. Miller was a leading factor in the organization of the Delamater Veterans Association, composed of his old associates at the Delamater works, and until the present year was its president. He was also a member of Scotia Lodge, F. & A. M., the Engineers' Club, New York Athletic Club and the St. Andrew's Society.

DAVID HAMILTON GILDERSLEEVE

David Hamilton Gildersleeve was born in Tenafly, N. J., August 5, 1867, and died in New York City, July 30, 1909. He was educated at Stevens Institute of Technology, Hoboken, N. J., and graduated in 1889 with the degree of M.E. For nearly ten years thereafter he was active in gas engineering and the construction and selling of pumps and hydraulic machinery, being associated with the United Gas Improvement Company of Philadelphia, the John H. McGowan Company of Cincinnati, and the Snow Steam Pump Works, New York.

For three years, during and following the Spanish-American War, he served as first lieutenant, United States Corps of Engineers in Cuba, and as assistant engineer of the Department of Havana had charge of the mechanical work executed and planned there. In 1904 he became associated with the C. W. Hunt Company, of West New Brighton, N. Y., as sales manager, which position he resigned in February 1909 to become one of the partners in the shipbuilding firm of the Waters, Gildersleeve, Colver Company, of West New Brighton, Staten Island.

Mr. Gildersleeve became a member of the Society in 1908. He was a member of the Machinery Club, the American Gas Institute, the New York Railroad Club, Dry Dock Association, Staten Island Club, Royal Arcanum, Staten Island Association of Arts and Sciences, Spanish War Veterans Association, the Chi Phi Fraternity, and was Secretary of the Stevens Alumni Association.

A. W. K. PEIRCE

Arthur Warren Kendall Peirce died April 13, 1909, at Driehoek, Transvaal, South Africa, where he had been located since 1897. He was born in West Boylston, Mass., November 19, 1873. His preliminary education was acquired in the Plymouth, Mass., high school, and his technical education by home study and experience in the engineering departments of various electrical companies.

In July 1897, he was appointed electrician to the Knights Deep, Ltd., a gold mining company in the Transvaal, and a year later became consulting electrical engineer to the Consolidated Gold Fields of South Africa, Ltd., a corporation controlling a number of mines in the Transvaal, continuing in this position until 1906. After a trip to England he returned to South Africa in April 1907, to accept an appointment with the Victoria Falls Power Co., Ltd., of Germiston, Transvaal, which he retained to the time of his death.

Mr. Peirce was also a member of the American Institute of Electrical Engineers, the South African Association of Engineers, the Mechanical Engineers' Association of the Witwatersrand, and an associate of the Chemical, Metallurgical and Mining Society of South Africa. He made many extensive trips through the various mining regions of America in search of information regarding hoisting from deep mines, in which work he was professionally interested.

JANG LANDSING

Jang Landsing, whose death occurred July 10, 1909, was born in Heong San, China, October 11, 1864. He was graduated from the Worcester Polytechnic Institute in June 1887, with the degree of B.S.

He was apprenticed to the Washburn Machine Shops for three years, after which he became connected with the Pratt & Whitney Co., as draftsman, leaving after two years to accept a position as machine designer with the Brush Electric Co., of Cleveland.

About 1899 Mr. Landsing, working in cooperation with Mr. Joseph Bijur, assisted in developing a line of special machinery for the manufacture of the "Bijur" type of storage battery. Mr. Landsing became mechanical engineer and then superintendent of the General Storage Battery Co. and was in active charge of the company's large plant at Boonton, N. J., at the time of his death. This work afforded him unusual opportunity to exercise his mechanical ingenuity, and many of the company's successful machines are due to the combination of his fine mechanical judgment and designing skill. He organized and equipped a machine shop for the manufacture of the special tools used by the company and also the 300-kw. power plant. Mr. Landsing had the ability to carry out in an efficient and economical manner work with which he was not previously familiar.

Mr. Landsing was also consulting engineer of the Chinese Legation at Washington.

PERSONALS

Walter C. Allen, Jun.Am.Soc.M.E., formerly General Superintendent of the Yale & Towne Mfg. Co., Stamford, Conn., has been appointed General Manager. with headquarters in New York.

C. Kemble Baldwin, Mem.Am.Soc.M.E., contributed an article, Trailings Disposal Plant at the Wolverine Mill to the July 10 issue of *The Engineering and Mining Journal.*

J. F. Beecher, Assoc.Am.Soc.M.E., has entered the employ of the Pennsylvania Steel Co., Steelton, Pa., as draftsman in the mechanical department. He was formerly connected with the Solvay Process Co., Syracuse, N. Y., as draftsman.

J. R. Bibbins, Mem.Am.Soc.M.E., has become Assistant Engineer to B. J. Arnold, Appraisal Division, Public Service Commission, New York. He was formerly associated with the Westinghouse Machine Company, East Pittsburg, Pa., as Engineer.

Grant D. Bradshaw, Jun.Am.Soc.M.E., has severed his connection with the Illinois Steel Company, and has opened an office at 77 Jackson Blvd., as a Consulting Engineer.

Wm. B. Brendlinger, Assoc.Am.Soc.M.E., has been made Pittsburg Manager of the Ingersoll Rand Co. He was until recently New York Manager of the company.

Paul R. Brooks, Jun.Am.Soc.M.E., formerly General Sales Manager of the Machine Sales Co., Peabody, Mass., has become Resident Engineer of the Union Bag and Paper Co., Sandy Hill, N. Y.

Donald S. Brown, Jun.Am.Soc.M.E., has entered the employ of the Westinghouse Electric and Manufacturing Company, Pittsburg, Pa. He was recently associated with the Dayton Hydraulic Machinery Company, Dayton, O., in the capacity of Sales Manager.

J. J. Brown, Mem.Am.Soc.M.E., has been elected vice-president and general manager of the Wheeler Condenser & Engineering Co., Carteret, N. J. Mr. Brown recently resigned his position as general Western sales manager of the International Steam Pump Co.

J. Norman Bulkley, Mem.Am.Soc.M.E., formerly Chief Engineer of the United Engineering Company, Ltd., Johannesburg, South Africa, has accepted a position with the General Mining and Finance Corporation. Johannesburg, South Africa, as Consulting Electrical Engineer.

Charles E. Burgoon, Mem.Am.Soc.M.E., formerly Assistant Inspector of Electric Light Plants, Treasury Department, Washington, D. C., has been made Assistant Inspecting Engineer, Isthmian Canal Commission, Washington, D. C.

S. N. Castle, Assoc.Am.Soc.M.E., formerly connected with Welch & Co., is now with the New York office of the General Electric Co.

Alexander G. Christie, Assoc.Am.Soc.M.E., Research Assistant in engineering at the University of Wisconsin, has been made Assistant Professor of steam engineering, in charge of the steam and gas engineering laboratories.

Chas. E. Davis, Mem.Am.Soc.M.E., has been appointed General Manager of the Warner Gear Co., Muncie, Ind. He was formerly Superintendent of the automobile department of the American Locomotive Company, Providence, R. I.

Charles Day, Jun.Am.Soc.M.E., officially represented the Franklin Institute on the occasion of the presentation of the gold medals of the Aero Club of America to Messrs. Wilbur and Orville Wright by President Taft, in the East Room of the White House on June 10.

Edward P. Decker, Mem.Am.Soc.M.E., has accepted the position of Engineer with the Kemiweld Can Co., Detroit, Mich. Until recently he held a similar position with Westinghouse, Church, Kerr & Co., New York.

William B. Dodds, Jun.Am.Soc.M.E., has entered the service of the Consolidated Light, Power and Ice Company, Joplin, Mo. He was formerly associated with the Denver Gas and Electric Co., Denver, Colo.

Paul Doty, Mem.Am.Soc.M.E., has recently been elected president of the local business league, St. Paul, Minn.

Arthur T. Doud, Jun.Am.Soc.M.E., has become Mechanical Engineer of the Hale-Kilburn Metal Company, Philadelphia, Pa. He was formerly with J. G. White & Co., in the capacity of Cost Engineer.

Alfred E. Forstall, Mem.Am.Soc.M.E., has been elected honorary alumni trustee of Lehigh University, South Bethlehem, Pa.

G. Clinton Gardiner, Jr., Mem.Am.Soc.M.E., has been appointed General Foreman of Motive Power, Hudson Division, P. R. R., Jersey City, N. J. He was until recently General Foreman of the Belvidere Division of the railroad, Lambertville, N. J.

Harry Gay, Assoc.Am.Soc.M.E., formerly associated with the N. Y. C. & H. R. R. R., New York, in the capacity of Assistant Engineer, has accepted a position with A. L. Drum & Co., Chicago, Ill., as Mechanical Engineer.

William Paul Gerhard, Mem.Am.Soc.M.E., is author of a book on Sanitation and Sanitary Engineering.

William H. Gerrish, Mem.Am.Soc.M.E., has accepted a position with the Columbian Rope Company, Auburn, N. Y., as Superintendent of the soft fiber department. He was until recently associated with the Travers Manufacturing Company, New York, as Superintendent.

Walter B. Gump, Jun.Am.Soc.M.E., recently of Los Angeles, Cal., is now permanently located at Tacoma, Wash., and engaged in general mechanical and electrical engineering.

F. W. Hollmann, Jun.Am.Soc.M.E., has resigned his position as Steam Engineer of the Maryland Steel Co., Sparrows Point, Md., in order to accept the po-

sition of Assistant Mechanical Engineer for the Carborundum Company, of Niagara Falls, N. Y.

First Lieutenant Mark L. Ireland, Jun.Am.Soc.M.E., has been transferred from the Frankford to the Watertown Arsenal, Watertown, Mass., connected with the ordnance department.

J. E. Johnson, Jr., Mem.Am.Soc.M.E., has accepted a position with the Republic Iron and Steel Company, as General Superintendent of the Thomas, Ala., Division.

J. C. Jurgensen, Assoc.Am.Soc.M.E., Chief Engineer and Superintendent, St. Regis Hotel, New York, has resigned his position to take the chair of engineering plant instruction at Columbia University next fall. A new course has been established for training students in the duties of engineers in charge of power plants.

R. R. Keely, Mem.Am.Soc.M.E., has recently been made professor of electrical engineering in the Nova Scotia Technical College, Halifax, N. S.

Prof. William Kent, Mem.Am.Soc.M.E., has resigned his position as General Manager of the Sandusky Foundry and Machine Company, Sandusky, O.

A. R. Kipp, Mem.Am.Soc.M.E., formerly Superintendent of Motive Power of the Wisconsin Central Railway, has been appointed Mechanical Superintendent of the Chicago division of the Soo Line.

Nisbet Latta, Jun.Am.Soc.M.E., until recently located at Seattle, Wash., has entered the mill and gas engine department of the Allis-Chalmers Company, West Allis, Wis.

Ralph A. Lee, Jun.Am.Soc.M.E., until recently in the employ of Geo. F. Hardie, New York, has accepted a position with Walter Kidde, New York, as Assistant Building Superintendent.

Ray D. Lillibridge, Assoc.Am.Soc.M.E., has taken into partnership William L. Rickard, with offices at 100 Broadway. New York. They will continue to devote themselves to technical publicity, the partnership being under the name of Ray D. Lillibridge.

B. D. Lockwood, Mem.Am.Soc.M.E., formerly Mechanical Engineer of the Cleveland, Cincinnati, Chicago & St. Louis Railway, at Indianapolis, Ind., has resigned to accept a position as Assistant Chief Engineer of the Pressed Steel Car Company.

Daniel M. Luehrs, Jun.Am.Soc.M.E., presented a paper on the Ventilation of Steamships before the Toledo Society of Engineers, May 14.

H. J. Macintire, Jun.Am.Soc.M.E., formerly with the National Lead Company of Brooklyn, has resigned to take a position with the engineering department of Harvard University, attached to the instructing staff.

James H. MacLauchlan, Mem.Am.Soc.M.E., Engineer of the American Cement Engineering Company, Hudson, N. Y., has been transferred to the Yorktown, Va., office of the company.

James D. Macpherson, Mem.Am.Soc.M.E., has become Chief Engineer for Adolphus Busch, purchaser of the American Diesel Engine Company, St. Louis, Mo.

Mr. Macpherson was formerly Assistant Chief Engineer of the American Diesel Engine Company, New York.

Geo. B. Massey, 2d, Jun.Am.Soc.M.E., is author of Modern Gold Dredging, published in the August number of *Cassier's Magazine.*

Dr. Richard Moldenke, Mem.Am.Soc.M.E., Secretary of the American Foundrymen's Association, sailed in the middle of August, to attend the Copenhagen congress of the International Society for Testing Materials, and will go to Germany and France on professional business. He expects to return near the middle of October.

Chas. L. Newcomb, Jr., Assoc.Am.Soc.M.E., formerly located at San Francisco, Cal., has entered the service of the Deane Steam Pump Company, Holyoke, Mass.

E. W. Nicklin, Assoc.Am.Soc.M.E., has accepted a position with the Diamond Power Specialty Company, Detroit, Mich. He was formerly Mechanical Engineer of the Smith Engineering Company, Detroit, Mich.

Millard P. Osbourn, Jun.Am.Soc.M.E., formerly Mechanical Engineer with Warren Webster & Co., Camden, N. J., has opened an office under the name of Osbourn & Robinson, in the Pennsylvania Building, Philadelphia, Pa., where the firm will conduct a general business of supplying power plant equipment.

George A. Orrok, Mem.Am.Soc.M.E., is the author of Development of the Surface Condenser, which appeared in the June 1 issue of *Power and the Engineer.*

Dwight T. Randall, Mem.Am.Soc.M.E., late engineer-in-charge of fuel tests, Technologic Branch, United States Geological Survey, has associated himself with the Arthur D. Little Laboratory of Engineering Chemistry of Boston, in charge of the department of fuel engineering.

An article on Modern Power-Station Design, by H. de B. Parsons, Mem.Am. Soc.M.E., was published in the August issue of *Cassier's Magazine.*

A biographical sketch of Prof. Charles B. Richards, Mem.Am.Soc.M.E., was published in the June number of *Cassier's Magazine.*

M. E. Rupp, Jun.Am.Soc.M.E., will be located at Gatun, Canal Zone, in charge of erecting the steel and wooden forms for the Gatun Locks. He was formerly Computer-Estimator, Isthmian Canal Commission.

Geo. H. Shenberger, Jun.Am.Soc.M.E., has accepted a position with the Cast Thread Fitting and Foundry Co., Seneca Falls, N. Y., as Mechanical Engineer. He was formerly Draftsman with the Lehigh Coal and Navigation Co., Lansford, Pa.

Foster C. Slade, Assoc.Am.Soc.M.E., formerly with Westinghouse, Church, Kerr, & Co., New York, is now General Manager and Gas Engineer of the Willimantic Gas and Electric Light Company, Willimantic, Conn.

Ernest L. Smith, Jun.Am.Soc.M.E., has been made Sales Manager of the Grant-Lees Machine Company of Cleveland, O. He was until recently Western Representative of the Standard Roller Bearing Company of Philadelphia.

Carl A. Strom, Mem.Am.Soc.M.E., Mechanical Engineer of the steam shovel and dredge department of the American Locomotive Company, Richmond, Va., has been made Manager of the Rogers Works of the company at Paterson, N. J.

J. F. Taddiken, Jr., Jun.Am.Soc.M.E., has been transferred from the Grand Island, Neb., to the Chino, Cal., office of the American Beet Sugar Company.

Wm. Threlfall, Mem.Am.Soc.M.E., has resigned his position of General Manager of the Chapman Valve Co., Springfield, Mass.

Fred. E. Town, Mem.Am.Soc.M.E., has become Manager of the Otis Elevator Company, Pittsburg, Pa.

H. H. Vaughan, Mem.Am.Soc.M.E., has been elected President of the American Railway Master Mechanics' Association.

F. H. Vose, Jun.Am.Soc.M.E., formerly assistant professor of mechanical engineering in Washington University, St. Louis, Mo., has resigned to give similar instruction in the Case School of Applied Science.

George L. Wall, Mem.Am.Soc.M.E., Mechanical Engineer of the Lima Locomotive and Machine Co., Lima, O., has assumed the duties of Assistant General Manager.

S. S. Webber, Mem.Am.Soc.M.E., contributed an article on A High-Speed Corliss Engine, to the August issue of *Cassier's Magazine*.

Wm. H. Winterrowd, Jun.Am.Soc.M.E., formerly Roundhouse Foreman, L. E. A. & W. Ry., Alliance, O., has accepted a similar position with the Lake Shore and Michigan Southern Railway Co., Youngstown, O.

Edwin Yawger, Assoc.Am.Soc.M.E., presented a paper on the Leblanc Condenser before the June 23–25 convention of the Association of Iron and Steel Electrical Engineers.

THE JOURNAL

OF

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

VOL. 31 OCTOBER 1909 NUMBER 8

THE Hudson-Fulton celebration, now in progress in New York City, emphasizes as have few events the debt of the present age to the engineer. The American Society of Mechanical Engineers has entered into the spirit of the celebration by preparing an exhibit in the rooms of the Society as a modest representation of the engineering profession. The exhibit, which has been announced through the daily and technical press and the literature issued by the Hudson-Fulton Celebration Committee, illustrates the development in marine engineering, beginning with the days of Fitch, Fulton and Stevens. An account of the exhibit is published elsewhere in this number. It is fortunate that the Society could thus contribute to the features of the celebration and so emphasize the progress in engineering which is now being commemorated.

MEETINGS FOR OCTOBER

Meetings of the Society are to be held during the month of October as follows:

In New York, on Tuesday evening, October 12, at eight o'clock, in the Engineering Societies Building, with a paper by Prof. R. C. Carpenter of Cornell University upon The High-Pressure Fire System of New York City.

In St. Louis, jointly with the Engineers Club of St. Louis, on Saturday evening, October 16, when Professor Carpenter will again present his paper upon The High-Pressure Fire System.

In Boston, on Wednesday evening, October 20, at eight o'clock, jointly with the Boston Society of Civil Engineers in Chipman Hall

a paper will be presented by Prof. Gaetano Lanza and Lawrence S. Smith on Comparison of Results Obtained by the Use of Three Theories of the Distribution of the Stresses in Reinforced Concrete Beams, with the experimental results.

In conducting meetings in St. Louis and Boston the Society is entering into broader activities than ever before and affording the membership a greater opportunity to attend meetings, participate in the discussion of papers and meet members and engineers in attendance at the meetings. The meetings in St. Louis and Boston as well as in New York are to be regular meetings of the Society, with the same standards maintained in regard to papers, discussion and general conduct of the meetings that have been established by the conventions and other regular meetings of the Society held in previous years.

Of the two papers to be given in October, that by Professor Carpenter introduces a subject which should draw out a great deal of discussion. The first high-pressure fire system in the country was installed at Detroit in 1888, where it was designed to fill the mains by means of steam-driven pumps on boats. There are now systems installed or in process of construction in Philadelphia, Brooklyn, Baltimore, Boston, Buffalo, San Francisco, Toronto and possibly other places. In some of the installations multi-stage centrifugal pumps are employed and in others plunger pumps are used. There is therefore an opportunity for discussion of high-pressure systems, as such, and also of the relative advantages and characteristics of different types of pumps for high-pressure work.

The paper by Professor Lanza and Mr. Smith gives the results of extended experiments upon full-sized reinforced concrete beams with well-developed theories, the paper forming an important contribution to the all-important subject of reinforced concrete construction.

ANNUAL MEETING

Preparations are actively under way for the annual meeting to be held in New York, December 7–10, detailed announcement of which will be made later. Valuable papers have already been received. As advance publication must be given to papers presented at the meeting and ample time allowed for their preparation and distribution in order to secure discussion, papers submitted for the annual meeting should be in this office by October 15 and in no case later than November 1.

NOTICE OF AMENDMENT TO CONSTITUTION

Under the requirements of C57 notice is given of the following proposed amendments to the Constitution:

C45 *Public Relations Committee.* Amend C45 of the Constitution by adding after the words "Research Committee" the words, "Public Relations Committee."

Presented and approved under requirements of C57 (Washington, D. C.) May 5, 1909.

C10 *and* C11. Presented and approved under requirements of C57 at the business session of the Society at the Washington Meeting, May 5, 1909, as follows:

C10 An Associate shall be thirty years of age or over. He must have been so connected with some branch of engineering or science, or the arts, or industries, that the Council will consider him qualified to coöperate with engineers in the advancement of professional knowledge. He need not be an engineer.

Approved and confirmed by Council at its meeting June 2, 1909, with the following recommendation: Omit the words "He need not be an engineer."

C10 as finally amended to read:

C10 An Associate shall be thirty years of age or over. He must have been so connected with some branch of engineering or science, or the arts, or industries, that the Council will consider him qualified to coöperate with engineers in the advancement of professional knowledge.

C11 A Junior shall be twenty-one years of age or over. He must have had such engineering experience as will enable him to fill a responsible subordinate position in engineering work, or he must be a graduate of an engineering school. A person who is over thirty years of age cannot enter the Society as a Junior.

The Council recommend: To substitute for the last sentence of the amendment the following: "A person who is over thirty years of age shall not be eligible to membership in the Society as a Junior."

C11 as finally amended to read:

C11 A Junior shall be twenty-one years of age or over. He must have had such engineering experience as will enable him to fill a responsible subordinate position in engineering work, or he must be a graduate of an engineering school. A person who is over thirty years of age shall not be eligible to membership in the Society as a Junior.

[*Extract from* C57. At that annual meeting such proposed amendment shall be presented for discussion and final amendment, and shall subsequently be submitted to all members entitled to vote,

provided that 20 votes are cast in favor of such submission. The final vote on adoption shall be by sealed letter-ballot, closing at twelve o'clock noon, on the first Monday of March following."]

THE SOCIETY'S HUDSON-FULTON EXHIBIT

In keeping with the celebration of the discovery of the Hudson River and the successful application of steam to navigation, the House Committee of the Society has appointed a subcommittee, with Edward Van Winkle as chairman, and has prepared an exhibit of models, drawings, letters, books and other items of interest related to early steam navigation.

This exhibit is the only participation of any engineering organization as such in the celebration, and much credit is due Mr. Van Winkle for the time and attention devoted to its preparation. The aim has been to make it of interest to the general public as well as the engineer. The exhibit room is open from 9 a.m. to 5 p.m. every week day. A list of the exhibits follows:

The model of the Clermont, loaned by the Smithsonian Institution, shows that vessel as she was at the time of her maiden trip. After making several trips during the fall of 1807, the Clermont was docked at Browne's shipyard and fitted up for regular passenger traffic.

The model of the Phoenix, loaned by the Smithsonian Institution, shows Stevens' boat at the time of making her notable New York-Philadelphia trip—the first ocean voyage made by a steam vessel.

A model of a steamboat built by John Fitch in 1786, also loaned by the Smithsonian Institution, has a peculiar arrangement of oars dipping into the water something like a canoe paddle. Despite its clumsy appearance the boat made a trip of 20 miles on the Delaware River.

A 9-ft. model of the Deutschland, loaned by the Hamburg-American line, shows by contrast the remarkable development in steam navigation during the last one hundred years.

Fulton painted an oil portrait of himself while a pupil of Benjamin West. This portrait was presented to the Society by Mrs. R. Anna Cary.

The Fulton dining table, owned by the Society, is of mahogany, 8½ ft. long and 5 ft. wide. It was presented to Mrs. Egleston House by Robert Fulton and passed from her hands to Geo. W. Egleston, and from him to his brother Thomas Egleston, who presented it to the Society in 1891.

Two autograph drawings by Fulton are exhibited, one of them, a brush drawing of a high-level canal, presented by Cornelia J. Carll, shows his artistic ability as well as his mechanical genius. The other drawing is of the Sound steamer Fulton, built in 1813, and was presented by Louisa Lee Schuyler.

The drawing of the Fulton is reproduced on a bronze tablet made in connection with the Fulton monument erected by the Society over Fulton's grave in Trinity churchyard. The tablet also gives a short description of the Clermont.

Henry Harrison Suplee, member of the Committee on Society History, has

presented a photograph of a letter by Fulton describing his experimental boat on the Seine, with copies of other letters by Fulton and his friends.

A Hudson River Guide, published in 1850, loaned by H. J. Gelien, describes the various points of interest on the Hudson and gives the time of sailing of the Hudson River boats of that period.

An oil portrait of James Watt, presented by past members of the Council, a copy of a portrait by deBreda, now in the possession of John Scott of Hawkhill, Greenock.

An oil portrait of Capt. John Ericsson, painted by Ballin of Stockholm, shows the designer of the Monitor at the age of 59. A bust of Ericsson, by Kneeland, was presented to the Society by James Mapes Dodge, Past-President, Am.Soc.M.E.

A solid silver model of the Half Moon has been loaned by Tiffany & Co.

Model of the Monitor presented by Thomas F. Rowland who built the Monitor at the Continental Iron Works.

Models, exhibited by Ericsson at the Centennial Exposition, loaned by the United Engineering Society.

Early books on steam navigation, from the Library of the Society.

Copy of a letter from Fulton to Boulton & Watt in 1810, ordering an engine for another boat.

Copy of letters by Fulton's workmen.

Drawings showing the comparative size of the White Star S.S. Olympic, Clermont and Half Moon; of New York's early water works, corner of Centre and Reade Streets; a water works note issue in 1774; all loaned by Daniel Arthur.

Color print of the Half Moon.

Fac-simile of Rules and Regulations for passengers in the Clermont.

Sketch of James Watt discovering the condensation of steam.

Photographs of a letter written by Fulton to Boulton & Watt, describing the Clermont and ordering an engine for another steamboat. Presented by the Smithsonian Institution.

A print of the original oil painting by W. F. Halsall of the battle between the Monitor and the Merrimac in the collection of the late Thomas Fitch Rowland, the builder of the Monitor.

Bills, receipts, etc., written by John Fitch; stock certificate issued by John Rumsy; copy of New York Herald of 1815 containing items of steamboats; copy of Washington Gazette of 1821 attacking Fulton; all loaned by Dr. C. S. Bullock, of Stratford, Conn.

DECORATION OF THE FULTON MONUMENT

On the morning of September 24, in the presence of officers and members of The American Society of Mechanical Engineers and of the Pennsylvania Society, wreaths were placed on the Fulton monument erected in 1901 by this Society in Trinity churchyard, New York. The Society was represented by Jesse M. Smith, President, and Calvin W. Rice, Secretary. The Pennsylvania Society was represented by Robert Mazet, Vice-President, and Barr Ferree, Secretary. J. M. Schroeder, commissioner from Pennsylvania, was also present.

Members of both societies assembled in the lobby of the church and, preceded by Dr. Manning, rector of Trinity Church, marched to the Fulton Monument. Dr. Manning offered prayer in part, as follows:

Almighty God, Who givest breath to every living thing, and of whose power it is that peoples, nations and kindreds of men stretch forth the curtains of their habitations, we give Thee thanks for the patience and genius with which Thou has endowed men that they might bring into subjection the mighty forces of the universe, and fulfill Thy command to subdue and replenish the earth. We thank Thee this day especially for these services, to us and to all people, of that one whose faithfulness and whose gifts of knowledge opened the way for our ships to traverse the great waters, and whose prayer it was that "the liberty of the seas might be the happiness of the earth."

Bless this land of promise with honorable industry, sound learning and pure manners; fashion into one happy people the multitude brought hither out of many kindreds and tongues; indue with the spirit of wisdom those whom we intrust in Thy name with the authority of governance, that all things may be so ordered and settled by their endeavors upon the best and surest foundations, that peace and happiness, truth and justice, religion and piety, may be established among us for all generations. And hasten the time, we pray Thee, when all peoples of the earth shall dwell together in righteousness and peace, and war shall be no more.

All of which we ask in the name of Jesus Christ, our most blessed Lord and Saviour. Amen.

The wreaths were then placed on the monument and the Lord's Prayer was recited, followed by the benediction. "Taps" sounded by a Seventh Regiment bugler brought the exercises to a close.

GENERAL NOTES

GIFT TO THE LIBRARY

The Western Electric Company has presented its valuable patent specification library to the library of the American Institute of Electrical Engineers. This gift, which constitutes the largest accession since the original creation of the library, will be added to the rich collection of technical literature housed in the Engineering Societies' Building.

The library consists of 461 leather-bound volumes containing approximately 100,000 specifications collected at a cost of over $4000. These specifications begin with May 30, 1871, and run to December, 1908, thus covering the entire period of activity which includes the telephone, the electric light, electric railways and the electric motor. From May 30, 1871, up to the last day of 1887 the volumes are complete, and certified as containing all the specifications issued by the U. S. Patent Department. From July, 1887 to December 1, 1908, the volumes contain all the electrical specifications, which are not certified.

Mr. Edward Caldwell, chairman of the library committee of the Institute, has already taken in hand the proper installation of the books, that engineers may derive the greatest possible benefit from them, and has also taken measures to complete the set to date. This splendid contribution will doubtless prove one of the most valuable accessions possible, from the standpoint of practical utility, and will be likely to stimulate further generosity. It is a most fortunate coincidence that the Institute had already been presented with a set of specifications antedating the period included in this gift.

AVIATION WEEK AT RHEIMS

August 22 to 29 an aëronautic meet was held on the Béthény Plain, at Rheims, France, which has indicated unexpected progress in the science. In spite of some unfavorable weather conditions there was no fatal accident. There were 38 entries to the various contests, in which biplanes and monoplanes were about equally represented, the principal types being the Wright, the Voisin cellular, the Far-

man and the Curtiss biplane; and the Antoinette, the Blèriot and the Pelterie monoplane. In the competitions the biplanes showed themselves slightly superior, especially in regard to endurance, and the bicycle type of air-cooled motor outdid the motor-car water-cooled type of engine. In general, the heavier-than-air machine far surpassed the dirigible.

The principal contests were for the longest uninterrupted flight, the swiftest flight over outlined courses, passenger-carrying contests, and an altitude-contest. Prizes were offered to the value of $40,000.

The speed-contest for the Bennett International Aviation Trophy was won by G. H. Curtiss, representing the Aëro Club of America. Mr. Curtiss ran his 60-hp. biplane the 12.5 miles (twice around the course, in 15 min. 50$\frac{3}{5}$ sec. Mr. Curtiss also won the longer speed-race of 18.6 miles, in 23 min. 29 sec.; and in a dash once around made 6.2 miles in 7 min. 48$\frac{2}{5}$ sec., M. Bleriot winning this event in 7 min. 47$\frac{4}{5}$ sec.

The distance contest for the Grand Prix de la Champagne et de la Ville de Rheims was won on August 27 by M. H. Farman in a biplane of his own type fitted with 50-h.p. Gnome revolving-cylinder motor and Bosch magneto-ignition. The condition of the flight was only 31 miles; Mr. Farman covered over 118 miles, in 3 hr. 15 min.

Mr. Farman also won the passenger-carrying contest, carrying at one time two passengers and making best speed record with one.

The winning machine in the height-competition, driven by Latham, reached a height of 508.5 ft. 35,400 ft. has, however, been reached by a manned balloon, carrying the German aëronauts Berson and Suering, who were unconscious at their highest point of flight.

FIRST TRIENNIAL PAN-AMERICAN SCIENTIFIC CONGRESS.

The report to Congress of the delegates of the United States to the First Triennial Pan-American (Fourth Latin-American) Scientific Congress, held at Santiago, Chile, December 25, 1908, to January 5, 1909, makes formal acknowledgment of special obligation to Calvin W. Rice, Secretary Am.Soc.M.E., for assistance to the delegation of the United States in securing papers for the engineering section.

Regret is expressed by the delegates that no engineer from the United States was present as a delegate, at the sessions of the section. Special mention is made of valuable papers by William H. Burr, Mem.Am.Soc.M.E., Mem.Am.Soc.C.E. on Reinforced Concrete Construction; W. J. Wilgus, Mem.Am.Soc.C.E., on Inter-Continental

Railways, and Frank J. Sprague, Mem.Am.Soc.C.E., Member and Past-President A.I.E.E., on The Application of Electricity to Railways. Other papers contributed through the Society were listed in The Journal for November 1908, page 19.

Recommendations and resolutions were adopted by the section as follows:

The speedy completion of the Pan-American Railroad.

That the economical use of water be given special attention in the countries of America; for the purpose of executing systematic irrigation works and also to stimulate united action on the part of those dependent on irrigation for the use of their lands, that every effort be made to stimulate the spirit of solidarity in order that such irrigation works may be carried out.

That it is highly important that public water-supply systems be established in the largest possible number of communities.

That at the next scientific congress the committee on organization submit a larger number of topics relating to irrigation; that the delegates submit the laws and regulations, and present papers relating to the use of water in their countries, the irrigation systems in use, and those in course of construction, and under consideration.

Topics for a special international conference were further suggested as follows: Type of building in countries subject to earthquakes; type of construction best adapted for piers and quays when the rivers are of great depth and swift current; preservation of native engineering terms.

The next Congress will be held in Washington, D. C., in 1912. A provisional committee to take the necessary steps for the formation of a permanent organization committee in the United States was appointed as follows: Dr. L. S. Rowe, Chairman, the director of the Bureau of the American Republics, the Commissioner of Education of the United States, William H. Holmes of the Smithsonian Institution, George M. Rommel of the Department of Agriculture. Dr. Enrique Ribeyro de Lisboa, of Brazil, was elected president of the Congress, to serve three years.

OTHER SOCIETIES

INTERNATIONAL CONGRESS ON TESTING MATERIALS.

The International Congress on Testing Materials was in session at the University buildings, Copenhagen, Denmark, during the week of September 10. The meeting was opened by Alexander Foss, president of the association. An important paper was presented by Paul Larsen, on The Development of the Danish Cement Industry. Papers were read in French, German and English. The next meeting will be held in New York, in 1912. Chas. B. Dudley, Mem.Am. Soc.M.E., was elected president of the International Association. Dr. Dudley was the representative of the United States at the Congress.

AMERICAN MINING CONGRESS

The twelfth annual session of the American Mining Congress is now being held at Goldfield, Nev., September 27–October 2. Prof. Joseph A. Holmes, of Washington, D. C., has been appointed Honorary Vice-President, to represent the Society at the Congress.

During the year several committees have been at work conducting investigations, reports of which will be made by the Chairmen as follows: Committee on Vertical Side-Line Law, Geo. W. Riter; Coal Tax Insurance Fund, Samuel A. Taylor; General Revision of Mining Laws, Walter R. Ingalls; Standardization of Electrical Equipment, Dr. Edward B. Rosa; Prevention of Mine Accidents, H. Foster Bain; National Forest Service, Col. A. G. Brownlee; Alaskan Mining Laws, J. L. Steele. The question of bringing about a greater use of silver, and decreasing the rate of exchange with countries using a silver standard, will be discussed, and Moreton Frewen, of London, James J. Hill and John Hays Hammond, have been invited to speak on this subject.

The State of Nevada has appropriated $5000 to pay the expense of collecting and classifying a comprehensive display of the state's mineral at Goldfield.

AMERICAN INSTITUTE OF MINING ENGINEERS

The ninety-seventh meeting of the American Institute of Mining Engineers for the reading and discussion of papers was held at Spokane, Wash., beginning September 27, 1909. There was much of professional interest in the excursions connected with the meeting, which included visits to the great copper plants at Butte and Anaconda, the mining and metallurgical operations in the Coeur d'Alene district and in the vicinity of Salt Lake, the mining exhibits at the Alaska-Yukon-Pacifiic Exposition in Seattle, the Tacoma smelter, the steel plant and lead smelter at Pueblo, Colo., and a special excursion into Yellowstone Park.

Among the papers presented at the meeting were Modern Progress in Mining and Metallurgy in the Western United States; (Presidential Address), by D. W. Brunton, Denver, Colo.; The Influence of Bismuth on Wire-Bar Copper, by H. N. Lawrie, Portland, Ore.; Dust Explosions in Coal-Mines, by F. Bache, Ft. Worth, Ark.; The Formation and Enrichment of Ore-Bearing Veins, by George J. Bancroft, Denver, Colo.; The Assay and Valuation of Gold Bullion, by Frederic P. Dewey, Washington, D. C.; Protective Value of Humidity in Dusty or Gaseous Coal-Mines, by James Ashworth, Congleton, England; An Adjustable Pyrometer Stand, by L. W. Bahney, Palo Alto, Cal.; The Ruble Hydraulic Elevator, by J. McD. Porter, Spokane, Wash.; Cyaniding Slime, by Mark R. Lamb, Milwaukee, Wis.; The Filing of Assay Samples for Use in Technical Laboratories, by Louis D. Huntoon, New Haven, Conn.; Barite Industry of the United States, by A. A. Steel, Fayetteville, Ark. There were also discussions on papers previously presented.

ILLUMINATING ENGINEERING SOCIETY

The sessions of the third annual convention of the Society of Illuminating Engineers were held September 27-29 in the auditorium of the Engineering Societies' Building, 29 West 39th St. A historical and educational exhibit was also held at 5 West 39th Street, with exhibits arranged by manufacturers of the commercial types of electric and gas lamps and accessories, showing the latest developments in the production and utilization of light. Plans were made to include the Hudson-Fulton celebration then in progress, omitting professional sessions on Tuesday, and holding an evening reception at the Machinery Club, at the top of the Hudson Terminal Build-

ing, from which an extended view of the spectacular illumination was afforded.

Important reports presented at the professional sessions were that of the committee on nomenclature and standards, Dr. Alex. C. Humphreys, Manager Am.Soc.M.E., *Chairman;* the sub-committee on units of flux, Dr. Clayton H. Sharp, *Chairman;* Papers: The Ethics of Illuminating Engineering, by E. L. Elliott; The Progress of Illuminating Engineering in Europe, by W. T. Owens; Notes on Chemical Luminescence of Rare Earths, by Dr. Angelo Simonini; The Light of the Fire-fly, by Dr. H. E. Ives and Dr. W. W. Coblentz; The Principles of Shades and Reflectors, by Dr. Louis Bell; Standard Relations of Light Distribution, by A. J. Sweet; Tests of Moore Tube Installation, New York Post Office, by Dr. E. P. Hyde and J. E. Woodwell, Mem.Am.Soc.M.E. On Tuesday evening a lecture was delivered by Dr. Charles P. Steinmetz, Mem.Am.Soc.M.E., on The Physiological Effects of Radiation.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES

The twenty-fifth annual meeting of the Association of Edison Illuminating Companies was held at Briarcliff Manor, N. Y., August 31 to September 2, 1909. Reports were received at this time from a number of committees, including that of the Committee on Meters, presented by Joseph W. Cowles, Chairman; the Committee on Incandescent Lamps, John W. Lieb, Jr., Mem.Am.Soc.M.E., Chairman; the Committee on National Code, Wm. C. L. Eglin, Chairman; the Committee on Steam Turbines, Alex Dow, Mem.Am. Soc. M.E., Chairman; and the Committee on Electric Heating and Kindred Uses of Electricity, John F. Gilchrist, Chairman. Papers were also presented on Prepayment Meters, by F. G. Vaughan; New Low-Pressure Turbine Installations, by W. L. R. Emmet, Mem.Am.Soc.M.E.; Gas Power, by I. E. Moultrop, Manager Am.Soc.M.E.; Standard Colors for Power Station Piping, by J. P. Sparrow, Mem.Am.Soc.M.E.; Special Illumination Features of the Hudson-Fulton Celebration, by Arthur Williams; A Neglected Phase of the Insurance Question, by Caryl D. Haskins, Mem.Am.Soc.M.E.; and Rotaries vs. Motor Generator Sets for Central Station Service, by C. W. Stone, Mem. Am. Soc.M.E.

The sessions closed with a dinner to Thos. A. Edison, Hon. Mem. Am.Soc.M.E.

NEW ENGLAND WATER WORKS ASSOCIATION

The annual convention of the New England Water Works Association was held in New York September 8 to 10. The time of the convention was well divided between presentation and discussion of papers, excursions and general sociability. Four or five papers and several committee reports were presented at the business sessions. The excursion feature of the convention was a trip September 10, to the Ashokan Dam, where the new Catskill water supply for New York City is being developed.

At the opening session, Wm. W. Brush, Engineer of Distribution of the Water Works of New York City, presented an address outlining the water supply system of greater New York.

NOVA SCOTIA SOCIETY OF ENGINEERS

The third annual meeting of the Nova Scotia Society of Engineers was held September 10, at New Glasgow. The papers presented for discussion were: Some Memoranda on Land Surveying in Nova Scotia, by R. R. McKenzie; Forest Conservation, by Professor Sexton; Forest Preservation, by C. M. O'Dell; The Relation of Forests to Stream Flow, by D. McD. Campbell; The Timber Assets of Nova Scotia, by A. R. McClean.

Officers were elected for 1909 as follows: President, S. Fenn; Vice-Presidents, J. A. Stairs, J. W. McKenzie; Secretary, J. Lorne Allan; Council, Prof. R. R. Keeley, Mem.Am.Soc.M.E., A. R. McClean, H. C. Burchell, D. McD. Campbell, J. G. McKenzie, A. G. Robb, Mem.Am.Soc.M.E., C. M. Archibald, W. G. Yorston.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

The British Association for the Advancement of Science held its annual meeting at the University of Manitoba, Winnipeg, Man., during the week beginning August 25. Sir William H. White, Hon.Mem.Am.Soc.M.E., delivered the presidential address before the Engineering Section of the Association, which held five sessions.

Among the papers presented were: Hydroplanes or Skimmers, by Sir John Thornycroft; The City Hydro-Electric Plant, by C.B.Smith; Improvements in the Navigation of the St. Lawrence, by Lt-Col. W. P. Anderson; The St. Lawrence River, the Great Imperial Highway of Canadian Transportation, by Maj. G. W. Stephens; Engineering and Construction Features of the Panama Canal, by Col. G. W. Goethals;

The National Transcontinental Railway, by Duncan McPherson; Two Great Engineering Works on the Canadian Pacific Railway, by J. E. Schwitzer; Development and Future Possibilities of the Grain Industry of Western Canada, by G. Harcourt; Grain Handl ng, by W. B. Lannigan. Prof. J. B. Porter of McGill University made a preliminary informal report of the fuel tests being carried out by him for the Dominion Government.

The afternoons were chiefly occupied by excursions of engineering interest, among them to the yards and shops of the Canadian Pacific and Canadian Northern Railways, the high-pressure fire-service pumping plant, the municipal hydro-electric plant and St. Andrews lock on the Red River, etc. The evenings were devoted to popular lectures and social functions. The meetings were attended by six hundred delegates, including many from the United States.

THE INSTITUTION OF MECHANICAL ENGINEERS

The summer meeting of the Institution of Mechanical Engineers was held at Liverpool July 27 to 29, with an unusually large attendance. At the professional sessions the following papers were presented: Locomotives Designed and Built at Horwich, by G. Hughes; Reinforced Concrete, A. O. Auden; Advance of Marine Engineering, A. J. Macginnis; Electrical Operation of Textile Factories, H. W. Wilson; Indicating Gas Engines, Prof. F. W. Burshall.

Very enjoyable social features were provided and also engineering excursions, including trips to the Liverpool Electricity Works, shipyards and docks, the University laboratories, the Liverpool & Southport Electric Railway, Mersey Railway power house, and pumping station, the Horwich Locomotive Works, a Cunard liner, soap and match factories, a refrigerating plant, etc.

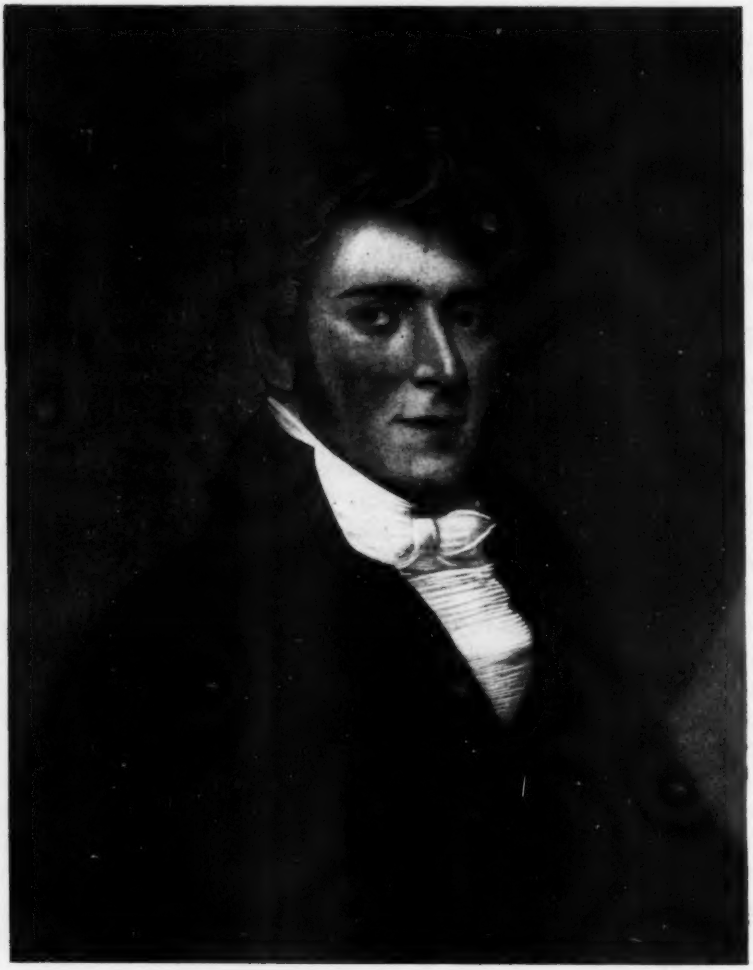
FULTON AS AN ENGINEER

Just now the popular conception of Fulton is as the man who *invented* steam navigation. To apply that title to him, however, is perhaps not to give sufficient credit to the work of previous investigators, from whose efforts Fulton obtained much of the knowledge applied in his own experiments. The achievement, therefore, for which he may be honored is the first successful *commercial* application of steam power to navigation on the Hudson River.

To think of him only in connection with the Clermont, however, is to lose sight of his versatility. Not only did he possess considerable talent as an artist, as evidenced by his oil paintings and drawings, but he also achieved distinction as a civil engineer in the design and construction of canal aqueducts and bridges, as an ordnance expert by his invention of torpedoes and as a naval engineer by his submarine work and the building of the first steam frigate.

His mechanical tastes, we are told, first appeared when as a boy of eight or nine he frequented the shops of mechanics, displaying such aptitude that he was allowed to help the apprentices and was always a welcome visitor. Hardly less marked was his ability to sketch readily the machines that drew his attention. The foundation of his future work with torpedoes was doubtless laid, when at fourteen he fairly haunted the shop of Messrssmith & Fenno, gunsmiths, in his home town. His biographer Reigart says that about this time the hard work of poling a boat home from a fishing trip suggested to Fulton the construction of paddle-wheels to propel the boat. The paddles were made detachable so that they could be hid in the bushes at the end of each trip; "and thus did they enjoy very many fishing excursions."

Though of so pronounced a mechanical bent, Fulton discovered such talent as an artist that at twenty-two he decided to become a pupil of Benjamin West in London. In 1797 he was invited to live with Joel Barlow in Paris and for seven years was as one of the family. During the time of his art studies, however, his mind had been occupied with mechanical things also. The first patent granted him, of which we have any knowledge, was in 1794 for a mill for sawing marble. Three years later he designed the first panorama exhibited



ROBERT FULTON

FROM A PAINTING BY HIMSELF, PRESENTED TO THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS BY MRS. R. ANNA CARY, NOVEMBER 30, 1897

in Paris. It is said that at about this time Fulton sketched on the wall of his room the plan of a steamboat, which he called "the image of what will yet traverse the river and ocean."

In 1797 he also invented and patented a double inclined plane for canals, which was followed by a series of similar inventions for bringing canal boats from a higher to a lower level or the reverse, a machine for spinning flax, one for rope making, an excavating machine for canal work, an air gun, a cable cutter, torpedoes made of copper cylinders containing about 100 lb. of powder and set off by a gun-lock operated by clockwork, and a submarine boat, the Nautilus.

Damage by flood to an aqueduct over which passed the Shrewsbury Canal in England, led Fulton to design a cast-iron sectional aqueduct, which was built for crossing the Dee River at Pontcysyltee, about twenty-three miles southwest of Chester, in Scotland. Cast-iron bridges were also built after Fulton's design in Wandsworth, England, and at several other places on the Surrey Railway. In 1807, Fulton was invited by Secretary-of-War Dearborn to make the surveys for a canal from Lake Pontchartrain to the Mississippi, but declined because of his time being occupied with torpedo experiments and the building of the Clermont. In 1810, he was appointed by the New York Legislature as one of the commissioners to explore the route of a canal between the Hudson River and Lakes Ontario and Erie.

His experiments with torpedoes and submarines in France appear to have filled the British mind with alarm. He was invited by the British Ministry to London and in 1814 prepared to demonstrate the destructive power of his invention on the French flotilla lying at Boulogne. The torpedoes exploded without doing any damage, however, due, as believed by Fulton, to the fact that they were hung perpendicularly by the side of the vessel whereas they should have been so arranged that the current would sweep them under the vessel's bottom. He afterward made changes to obtain this result, and in October 1805, a vessel prepared for the test was blown up in Walmar Roads, near Deal. He repeated this performance in New York harbor, shortly before the Clermont's first trip, using a brig's hulk for his demonstration.

In March 1810 Congress appropriated $5000 for experiments with Fulton's torpedoes, the sloop-of-war Argus being prepared for the tests. A strong netting was suspended from her sprit-sailyard and anchored at the bottom; the vessel was surrounded by spars lashed together; she had grappling irons and heavy pieces of iron suspended

from the rigging to drop on anything approaching; swords or scythes were fastened to long spars moving like sweeps, to mow off the heads of any who came near. Against this armor Fulton's torpedo was, of course, powerless, but it was admitted that any invention which would oblige a hostile vessel so to guard herself was of great importance in a system of defence. At this time Fulton tried out a harpoon and a cable cutter, both operated by the explosion of powder, and he later made experiments in the firing of cannon under water.

His initial plunge in a submarine was in the harbor of Brest in 1801. With three companions, Fulton went 25 ft. below the surface, remaining for an hour. The boat is described as being fitted with a mast and sail, which could be struck in about two minutes. Hand power was used for working some form of propeller. After the first trial, a cylinder of compressed air was used to freshen the vitiated air while the boat was submerged. A small glass window admitted enough light for movements to be directed. It appears that Fulton did not again take up work in this line until shortly before his death in 1815. A model of an improved boat was approved by Congress and work on the boat begun, but Fulton died before the hull was entirely finished.

Fulton's first experimental steamboat was tried on the Seine early in 1803. Robert R. Livingston, of New York, then United States Minister to France and himself a close student of the possibilities of steam navigation, had become interested in Fulton's ideas and had offered to provide funds for experiments. These proving successful, a contract was to be made for development in the United States. The night before the proposed trip of this boat, however, the hull proved too weak to sustain the heavy engine and boiler, and broke in two. The engine and boiler were raised and an almost entirely new boat built, measuring 66 ft. long and 8 ft. wide. The trial of this boat was satisfactory though her slow speed was somewhat disappointing to Fulton. Arrangements were then made to build a larger vessel in the United States, but owing to the lack of engine-building facilities in that country and in France, the engine was ordered from Boulton and Watt.

Fulton evidently went into the matter broadly and considered not only the propelling machinery but also the best form of hull for the desired results. In his patent specifications he writes: "The successful construction of steamboats depends on these parts (shape of bow and stern, draft, velocity, friction, total resistance, and power of the engine to give the necessary velocity) being well proportioned,

whether wheels or other propellers be used, with the right proportion of the parts above mentioned, steamboats may be navigated by the propelling power of wheels, endless chains or paddles, but without the proportions which shall hereafter be explained, they cannot be successfully navigated, with either wheels, endless chains, paddles, or any other mode of taking the purchase on the water."

In his calculations Fulton used data obtained by Col. Mark Beaufoy from experiments made at Greenland Dock, near London. In his first specifications he gives the following figures for a boat to run one mile an hour to show his method of calculating the necessary power for different rates of speed:

	Pounds
The plus and minus pressure of 1 ft. 0.88 lb., which multiplied by 36 ft., the boat's bow, is	31.68
Friction on 848 feet of bow and stern, at 0.70 lb. for 50 sq. ft., is	11.90
Friction on 2,200 sq. ft. of the body of the boat is	30.80
Total resistance of the boat	74.38
A like power for the propellers	74.38
Total power	148.76

This power must be felt at propellers repelling water one mile an hour, or one foot and a half a second, which is one-fourth slower than the motion of the piston; consequently one-fourth may be deducted from 148.76, leaving 111.57 the power of the engine: a cylinder 4 inches diameter, equals 16 round inches, and 8 lb. to the inch, gives 128 lb., which is sufficient power. The periphery of the propeller wheels must run two miles an hour, or 3 feet a second, equal to 180 feet a minute. If 11½ feet diameter 34½ ft. round, 5¼ revolutions in a minute gives 181 ft.; the engine strikes 15 double strokes a minute, the wheels make 5¼ revolutions in a minute; this is a proportion of near 3 to 1; hence the first mover or pinion from the engine may be 2 ft. diameter, the wheel on the water wheel shaft 6 ft. diameter: the total resistance of the boat is 74.38 lb.; one square foot of propellers running 1 mile an hour is 3.25; resistance 23 feet will give 74.75: this is 11½ ft. in each propeller.

In his second specifications Fulton deals more specifically with the calculations for the Clermont. He writes as follows:

My first steamboat on the Hudson's River was 150 ft. long, 13 feet wide, drawing 2 ft. of water, bow and stern 60 deg.; she displaced 36.40 cubic ft., equal 100 tons of water; her bow presented 26 ft. to the water, plus and minus resistance of 1 ft.; running 4 miles an hour.

	Pounds
12.37 lb. multiplied by 26, the bow of the boat	321
Friction on 2,380 superficial feet of bottom and sides, at 7.50 lb. or 50 superficial feet	352
Total resistance of the boat, running 4 miles an hour	673

	Pounds
A like power for the propellers	673
Total power felt at the propellers	1,346
The boat running 4 miles an hour is 6 feet a second; this is 3 times faster than the piston; hence, multiplied by	3
Necessary power of the engine, the piston running 2 ft. a second	4,038

This will require a 22-in. cylinder allowing 9 lb. purchase to the round inch; this engine would not occupy in the boat more space than in the small one, and it would not weigh 2 tons more than the 17-in. cylinder; hence, say weight of engine 22 tons, weight of boat 40 tons, total 62 tons; this leaves 38 tons for passengers or merchandize, with ample space, before it could bring her down to 2 ft. in the water; but drawing not more than 18 in. before cargo or passengers were in, and her resistance being diminished one-third, the above power would drive her 4½ miles an hour. The two preceding examples exhibit in a clear point of view the advantage to be gained in building a large boat, to carry a large and powerful engine.

A list of the steam vessels built by Fulton after the Clermont is given elsewhere in these pages. The Vesuvius, built in 1814, is said to have played an important part in the battle of New Orleans as a transport for troops and supplies.

By some Fulton is accused of plagiarism. It is true that he used data obtained by Mark Beaufoy in experiments made in England on the form of hulls. It also may be true that Fulton inspected Symington's boat in England and made such notes and observations as enabled him to build his boat on the Seine. But Beaufoy never applied his data to the building of steam vessels and Symington's boat never reached the stage of commercial utility.

It is interesting to note Fulton's own view of his work in his patent of February 11, 1809, in which he claims to be " the first who had laid down rules that will secure success in building such boats or vessels; no patent or publications having hitherto appeared, in which exact and mathematical principles are explained to guide artizans to success in works of this kind."

He says further: "The development of these principles is indispensable to the most perfect construction of steamboats; it is owing to a want of accurate knowledge of these principles that the essays on steamboats, which have been made in different countries for thirty years, have hitherto failed."

A BRIEF HISTORY OF EARLY STEAM NAVIGATION IN THE UNITED STATES

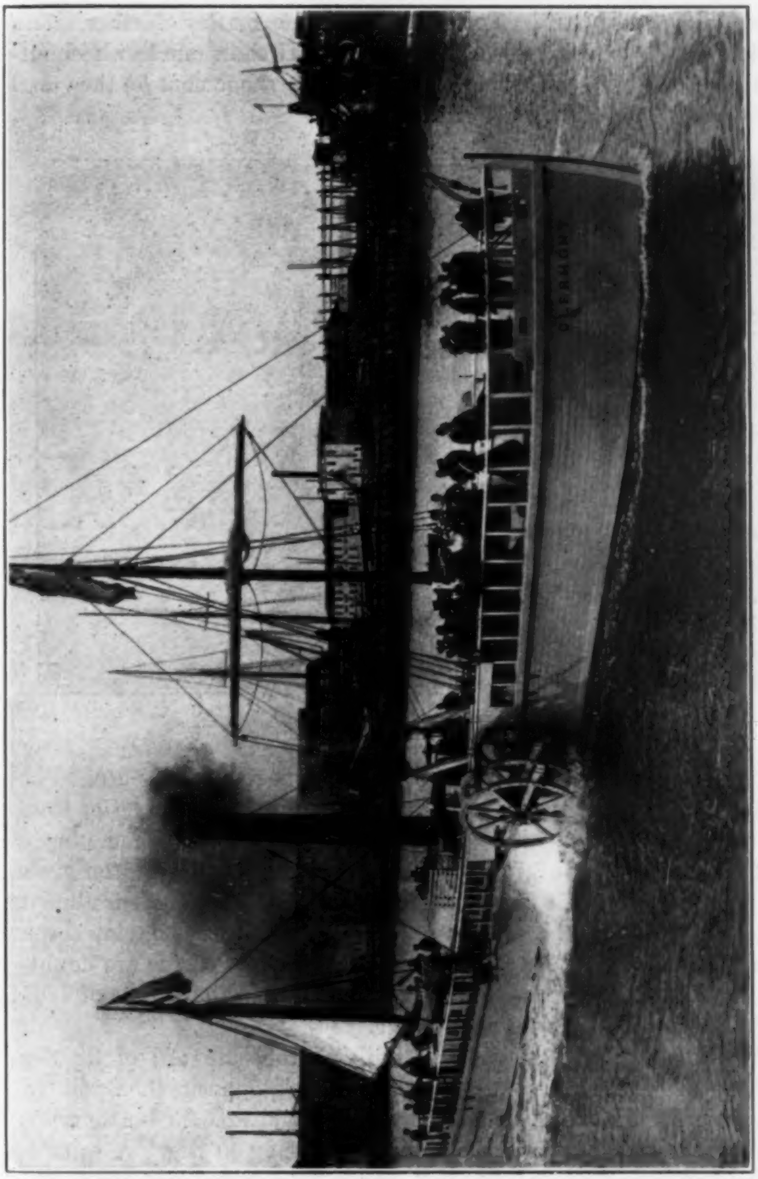
The celebration at this time of the first successful commercial application of steam power to navigation makes of interest the following brief review of the work of three men—Fulton, Stevens and Fitch—who played an important part in the development of the art.

Fulton, who possessed considerable talent as an artist, appears to have first taken up the study of steam navigation while a pupil of Benjamin West in London. Later he went to Paris and while there interested Robert R. Livingston, of New York, in his ideas, to such an extent that Livingston agreed to supply the funds necessary for experiments. These proving successful a contract was to be made for development in the United States.

A vessel 66 ft. long and 8 ft. wide was built in France, and fitted with an engine the builders of which are not stated, though probably they were Boulton & Watt of England. After some mishaps, a successful trip was made on the Seine in 1803. Arrangements were then made to build a larger vessel in the United States, but owing to the lack of engine-building facilities in that country and in France, the engine was ordered from Boulton & Watt. In Fulton's diary the cost of the engine is given at 548£ and that of the copper boiler, weighing 4,399 lb., at 2s. 2d. the pound or £476 11s. 2d. The boiler was bought of Cave & Son.

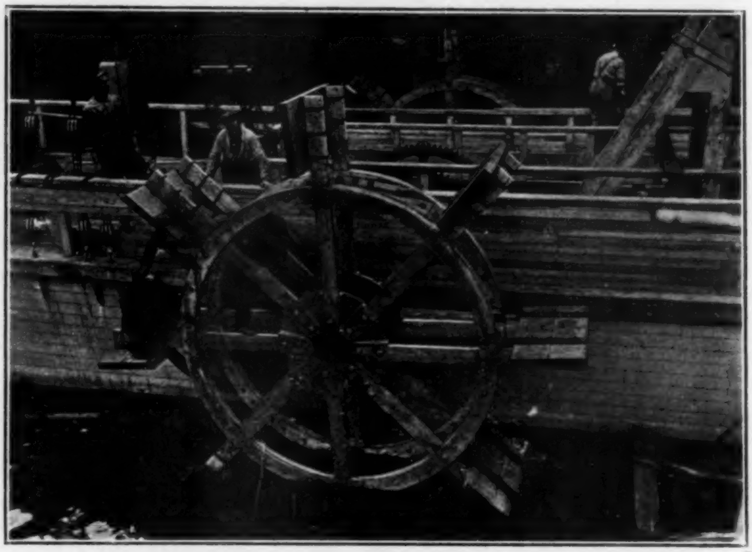
Existing data of the engine are somewhat at variance, chiefly in regard to the relative arrangement of crankshaft, paddle-wheels and flywheel, though there is no doubt that the cylinder was 24 in. in diameter and the stroke 4 ft. Professor Renwick in his life of Fulton says, "On the same axle with the crank were toothed wheels, which gave motion to pinions, and to axles of the pinions was adjusted a heavy flywheel." The paddle-wheels were evidently on the crankshaft but this is not stated. The foregoing arrangement is the same as that shown in Woodcraft's work on Steam Navigation published in London in 1848. The accompanying sketch, taken from Fulton's specifications of patent in 1809, shows but one flywheel, driven by pinions from the crankshaft, on which the paddle-wheels were placed.

MODEL OF THE CLERMONT AS SHE APPEARED ON HER INITIAL TRIP



THE CLERMONT II ON HER OFFICIAL TRIAL TRIP. SHE WAS BUILT AT THE YARDS OF THE STATEN ISLAND SHIPBUILDING CO., FROM PLANS DRAWN BY F. E. KIRBY AND J. W. MILLARD

The model of the Clermont from the Smithsonian Institution shows the flywheel and paddle-wheels on the same shaft driven by gears from the crankshaft. To complicate the matter further, data obtained by the designers of the Clermont II show one flywheel outside the hull on each side, and this is the arrangement on the vessel built for the Hudson-Fulton celebration.



A PADDLE WHEEL OF THE "CLERMONT" II

The dimensions of the hull are also a matter of dispute. The Smithsonian model was built from a description in a letter from Fulton to Boulton in which the length is given as 175 ft., the beam 12 ft., and the depth 8 ft. In his patent specification Fulton gives the dimensions as 150 ft. long and 13 ft. wide. In the enrollment made at the New York custom house, the vessel "having been enlarged" measured 150 ft. long and 18 ft. wide. These are doubtless the dimensions after the vessel was altered in the winter of 1807 to fit her for regular passenger traffic.

The hull of the Clermont was built at the shipyard of Charles Browne on the East River near Corlaer's Hook, opposite the Brooklyn Navy Yard. The sides of the hull were straight and the bottom flat, the angle included by both bow and stern being 60 deg. A square-rigged mast was placed forward and a schooner-rigged mast aft. During the first voyage a tiller was used for steering, but a wheel was afterward placed forward over the engine.

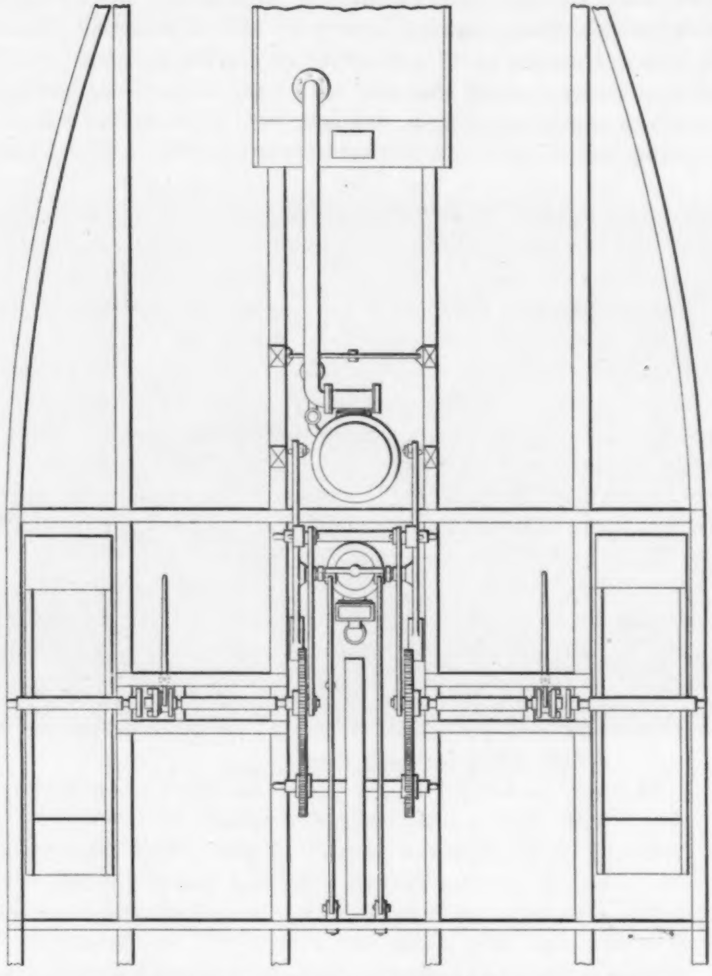
The first trip was made on Monday, August 21, 1807, from New York, the Clermont leaving at 1 p.m. and arriving at Clermont, Livingston's estate, at 10 a.m. Tuesday, having covered 110 miles. On Wednesday, leaving Clermont at 9 a.m., Albany was reached at 5 p.m.—a run of 40 miles in 8 hours. On Thursday at 9 a.m. the Clermont left Albany and arrived at Clermont at 6 p.m., leaving at 7 p.m. and arriving in New York on Friday at 4 p.m. In describing the trip in a letter to a newspaper, The American Citizen, Fulton wrote that the wind was ahead both ways so that no advantage was derived from the sails.

In discussing with Livingston the possibilities of financial return from the passenger traffic, Fulton wrote: "By carrying for the usual price there can be no doubt but the steamboat will have the preference because of the certainty and agreeable movement. I have seen the captain of a fine sloop on the Hudson. He says the average of his passages have been 48 hr. For the steamboat it would have been 30 certain. The persons who came down with me were so pleased that they said were she established to run periodically they would never go in anything else."

The following rates were charged to various points from NewYork: Newburgh, $3, 14 hr.; Poughkeepsie, $4, 17 hr.; Esopus, $4.50, 20 hr.; Hudson, $5, 30 hr.; Albany, $7, 36 hr. In Renwick's life of Fulton, in addition to the foregoing rates, these details are given:

> All other way passengers to pay $1 for 20 miles passage and a half dollar for each meal.
>
> Children between 1 and 5 years, one-third price if sleeping with those having charge of them.
>
> Young persons between 5 and 13 years, half price sleeping two in a berth; full price sleeping one in a berth.
>
> Servants, two-thirds price for one in a berth; one-half price for two in a berth.
>
> Each passenger paying full price was allowed 60 lb. of baggage; if less than full price, 40 lb. of baggage. For surplus baggage 3 cents a pound was charged.

There is evidence that the regular trips of the Clermont were made under some difficulties, for the North River sloops, perhaps seeing in the Clermont the beginning of successful competition for their freight and passenger traffic, sought opportunities to run afoul of her and damage her paddles. Fulton was obliged to construct guards for the paddlewheels, but one writer states that the spirit of

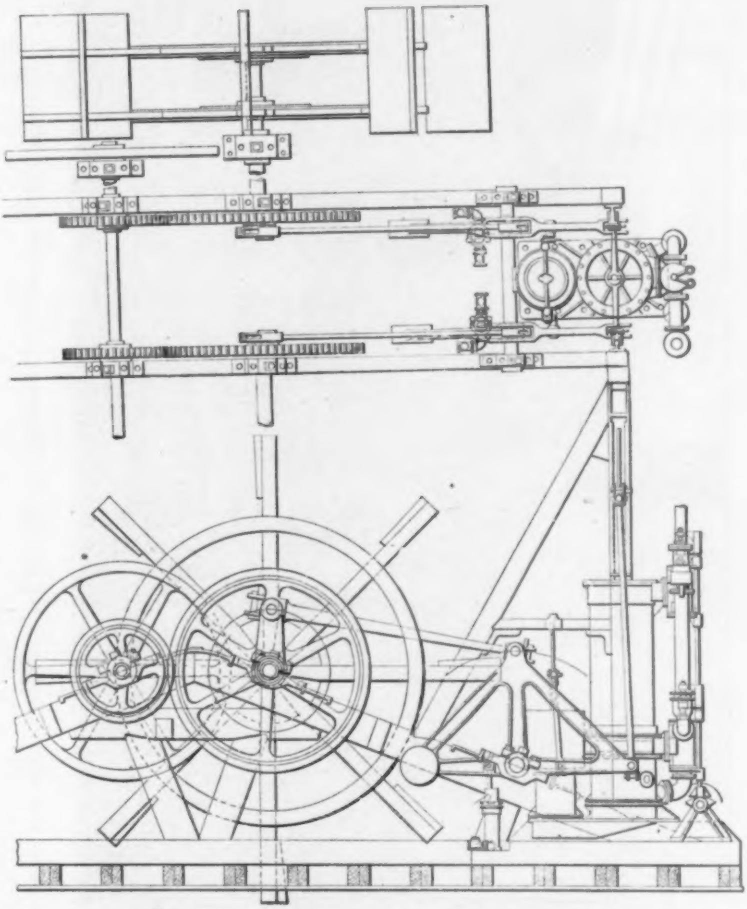


Plan of the Clermont's Engine from Fulton's Patent Specifications

hostility became so strong that the Legislature passed a law to punish any person who attempted to injure the boat.

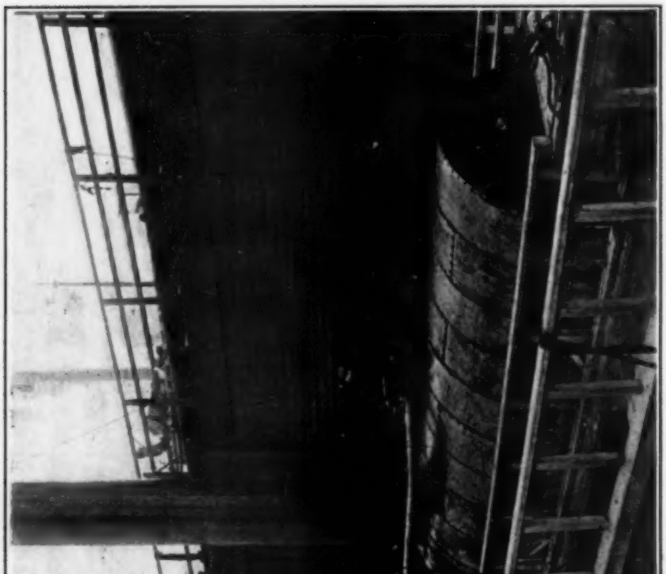
The Clermont made several trips during the fall of 1807 at stated times advertised in the newspapers. During the winter extensive alterations were made to provide passenger accommodations and in the spring of 1808 the Hudson River trips were resumed. At some time her name was changed to North River. Under favorable con-

ditions the journey to Albany was made in twenty-eight hours at the rate of six miles an hour. Sometimes one hundred passengers were carried.



PLAN AND ELEVATION OF THE ENGINE IN THE CLERMONT II

Not long after the maiden trip of the Clermont, probably some time in 1808, repair shops were built at North Point, Jersey City, the equipment including the first drydock in the United States, measuring 200 ft. long, 36 ft. wide and 16 ft. deep. Here Fulton built the machinery for his third boat, Car of Neptune, launched in the fall of 1809.



View from the Stern, Showing Boiler, Stack, Crosshead Guide and Paddle Wheel

After the Clermont, the vessels built by Fulton were as follows: Rariton,—it was so spelled at that time—spring of 1809; Car of Neptune, fall of 1809; Paragon, 1811; a Hudson River ferryboat, 1811–12; an East River ferry boat, 1812—the floating ferry docks or bridges were also designed by Fulton; Camden, 1812; Richmond, Washington, Fulton, ferry boat Nassau, 1813; Vesuvius, 1814. In

View of the Engine, Showing Throttle Valve, Steam and Exhaust Lines and Part of the Valve Gear

December 1814 Fulton contracted with the Government for the employment of the steamboats Vesuvius, Etna, New Orleans, Natchez and Buffalo as transports on the Mississippi and Ohio Rivers. How many of these had been completed at that time is not known. The Chancellor Livingston was not completed until after Fulton's death in February 1815. The first steam frigate, first called Demologes and later Fulton the First, was designed by Fulton and launched in

1814. She was not completed until after Fulton's death and was subsequently used as a receiving ship at the Brooklyn Navy Yard.

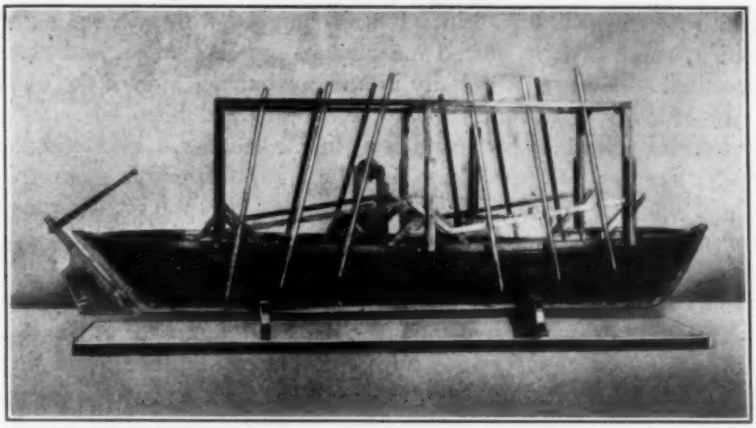
It is said that John Stevens began his work in steam navigation in 1791, having received an inspiration from viewing the trial of one of Fitch's boats. In 1798, a steam-propelled vessel was tried on the Passaic River. The New York Legislature was petitioned by Stevens for a monopoly of steam navigation but the petition was not granted.

In 1804 a 68-ft. boat, 14 ft. wide, fitted with a single-screw propeller, was built by Stevens and in 1805 a twin-screw boat was launched on the North River. The machinery of this boat was afterward placed in a larger boat, the Phoenix, 103 ft. 3 in. long, 16 ft. wide and 6 ft. 9 in. deep, which was launched on April 9, 1808, at Hoboken. In a statement given by John Stevens to the New York Evening Post of October 20, 1808, he says that on one of her trips the Phoenix left Hoboken on September 27 at 12.30 p.m. and owing to delays in adjusting the machinery, strong head winds and a heavy swell, did not reach Perth Amboy till 7.15. The next morning she left Perth Amboy at 12.30, arriving at Hoboken at 6 p.m., having sailed 30 miles in 5 hr. 35 min., or more than 5½ miles an hour. It is stated by some writers that the Phoenix made the sea voyage to Philadelphia during the summer of 1808, but the foregoing statement by Stevens shows that the trip could not have been made until later.

In the spring of 1809 the Phoenix made a number of trips between New York and New Brunswick, a distance of 37 miles in 9½ hr. including stops. However, as the New York Legislature had granted Fulton a monopoly of steam navigation and as the nearly completed Rariton, Fulton's second boat, was intended for operation over this course it was decided to sail the Phoenix to the Delaware River by way of the Atlantic. She left New York on June 8, 1809, arriving at Philadelphia on June 17. Thus was accomplished the first sea voyage of a steam-propelled vessel.

Judging from the models the lines of the Phoenix were much superior to those of the Clermont. The engine also shows greater simplicity. The Phoenix ran as a passenger boat on the Delaware, stopping at Philadelphia, Bordentown and Trenton, where connection was made with stages across New Jersey to New Brunswick, one of the terminals of the Rariton. After running for a number of years over this route the Phœnix was wrecked at Trenton in 1814.

The model of John Fitch's steamboat represents one built in Philadelphia in 1786, a successful public trial being made on the Delaware River, on July 27 of that year. The length was 34 ft.;



Model of John Fitch's Boat Built in Philadelphia and tried on the Delaware River in 1786

The Phoenix, built by John Stevens. In 1809 she made an Ocean Trip from New York to Philadelphia

width 8 ft.; depth, 3 ft. 6 in. It was equipped with a steam engine, which, connected by geared machinery, sprocket wheel and chain, operated oars placed vertically in a frame on each side of the boat.

In 1788 Fitch completed his first commercial boat for carrying passengers, and it was driven in a similar manner. This boat was 60 ft. long and 8 ft. wide. In July 1788, a trip was made from Philadelphia to Burlington, about 20 miles, the longest ever made by any steamboat up to that date. On October 12, 1788, the boat carried 30 passengers from Philadelphia to Burlington in 3 hr. 10 min., a speed of over six miles an hour. In 1791 Fitch built another boat, which attained a speed of eight miles an hour, and continued to run on the Delaware River, carrying passengers and freight, for three or four months. In 1796, another boat was built by Fitch and tried on the Collect Pond in New York. It is said that this boat was fitted with a screw propeller.

Fitch was not able to obtain sufficient financial backing for his experiments and was therefore unable to develop further his ideas of steam navigation.

PERSONALS OF THE MEMBERSHIP AM. SOC. M. E.

Walter C. Allen, formerly general superintendent of the Yale & Towne Manufacturing Company's plant at Stamford, Conn., has recently been appointed general manager of that company with headquarters in New York.

F. C. Armstead, supervising engineer of the stoker department of the Westinghouse Machine Co., for a number of years located at East Pittsburg, now has his headquarters at the Westinghouse Works, Attica, N. Y.

Dickerson G. Baker, formerly consulting engineer, Samuel M. Green, Inc., has accepted the position of works manager, Blake & Knowles Steam Pump Works, East Cambridge, Mass.

A. Bement has been appointed by Governor Deneen delegate to represent the State of Illinois at the American Mining Congress at Goldfield, Nev.

Wm. A. Bole has been appointed assistant manager of the works of the Westinghouse Machine Co., E. Pittsburg, Pa., with particular jurisdiction over the Trafford Works.

Chas. J. Caley has resigned as general manager of the Russell & Erwin Mfg. Co., because of ill health. He is still a member of the board of directors and later it is expected will act in an advisory capacity.

Wm. T. Donnelly has been appointed official representative of the Manufacturers' Association of Brooklyn on the inspection trip to the Adirondacks under the auspices of the State Water Supply Commission. This trip is being made to inspect the available water supply with regard to power, storage and flood conditions.

Ralph E. Flanders is the author of a book on Gear-Cutting Machinery.

Frank A. Haughton has become associated with the Taylor Iron and Steel Co., High Bridge, N. J.

Clarence H. Helvey has accepted a position with the Hamilton Engineering Co., Hamilton, O. He was until recently in the service of the Power Equipment Co., New York.

An illustrated article on The Manufacturing Laboratory at Neubabelsberg, by Henry Hess, was published in the September 9 issue of *The American Machinist.*

H. A. S. Howarth has contributed an article on Simple and Automatic Stop-Pins for Press Work, to the September issue of *Machinery*.

Mark L. Ireland, who was recently stationed at the Watertown Arsenal, Watertown, Mass., will be relieved from the Ordnance Department, U. S. A., and return to the Coast Artillery Corps, Fort Stevens, Ore., after October 5.

Louis L. Johnson, formerly in the employ of the Westinghouse Machine Co., Chicago, Ill., has been appointed gas engineer of the electrical department of the Southern Pacific Co., San Francisco, Cal.

Wm. A. Jordan has become associated with the Charles Warner Co., Wilmington, Del. He was formerly connected with Stephen T. Williams. and staff in the capacity of industrial engineer.

Prof. R. R. Keely, and A. G. Robb have been elected to the council of the Nova Scotia Society of Engineers.

William F. Lee, formerly engineer for the C. W. Hunt Co., New York, has entered into partnership with C. J. Roelker of Richmond, Va. They will do general engineering work throughout the South, under the firm name of Roelker and Lee.

Jas. G. Maclaren has been transferred from the home office of the Lamson Consolidated Store Service Co., at Boston, Mass., to look after engineering work in the New York department.

A biographical sketch of Melville W. Mix was published in the September number of *Cassier's Magazine*.

Curtis C. Myers, has resigned as mechanical engineer of the Diamond Chain and Manufacturing Co., Indianapolis, Ind., to accept the position of shop coördinator in coöperative engineering courses at the University of Cincinnati.

Robt. W. Rogers is now connected with the Erie Railroad, with headquarters in the general mechanical superintendent's office at Meadville, Pa.

A. H. Sabin has been elected a fellow and member of the honorary council of the North British Academy of Arts and Sciences.

Robert Shirley has been appointed works manager of the Chapman Valve Mfg. Co., Indian Orchard, Mass. Until recently he was associated with the Pratt & Cady Co., Hartford, Conn., as mechanical engineer.

Chas. H. Speer has entered the service of the Algoma Steel Co., Ltd., Sault Ste. Marie, Ont., in the capacity of assistant engineer. He was formerly consulting engineer with Carr & Speer, New York.

H. L. Watson has been transferred from the Cleveland office to the Boston office of the Allis-Chalmers Co.

NECROLOGY

WILLIAM THOMAS REED

William Thomas Reed, Mem.Am.Soc.M.E., was born June 27, 1847, London, England. He received his education at the Commercial College, Kent, and entered railway service in 1862 as a machinist; was apprenticed to the London, Chatham & Dover Railway, 1869–1871; became a machinist on the Grand Trunk Railway, Canada, in 1871, afterwards serving the road as leading machinist, at Stratford, Ont., 1875–1877, foreman erecting and other shops, at Montreal, P. Q., 1877–1883; locomotive foreman, at Belleville, Ont., 1883–1887.

In 1887 he became master mechanic of the Western division, Canadian Pacific Railway; and from 1888 to 1894, acted as general master mechanic, St. Paul & Manitoba Railway. From 1895 to 1898 he was superintendent of the Chicago Great Western Railway, and from 1893 to 1901, superintendent of motive power and machinery, Seaboard Air Line Railway, Portsmouth, Va. He was locomotive superintendent for the Jamaica Government Railway, from 1902 to 1906, at which time he was appointed locomotive superintendent of the Gold Coast Government Railway, West Africa. He held this position until 1908, when he received another appointment on the Jamaica Government Railway. In 1890 he became a member of this Society.

Mr. Reed died of malarial fever, July 1, 1909, only a few hours after leaving Kingston wharf on leave of absence, and was buried at sea.

ARCHIBALD W. BLAIR

Archibald W. Blair, Jun.Am.Soc.M.E., died July 17, 1909 at the home of his father, Dr. W. W. Blair, in Princeton, Ind., where he was born June 4, 1865. He was a graduate of the Princeton High School and took a special course in mechanical engineering at Purdue University. After serving an apprenticeship in the foundry, machine, boiler and smith shops of the Princeton Foundry and Machine Works, Mr. Blair went in 1890 to Cincinnati where he attained high standing as a mechanical draftsman. At the time of his death he was chief

draftsman of the American Laundry Machinery Company and also instructor in the Ohio Machinists' Institute, and a member of the American Association of Engineers. He was a man of many excellent traits and high attainments and will be greatly missed by his associates. Mr. Blair entered the Society as a Junior in 1898.

THE JOURNAL

OF

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

VOL. 31 MID-OCTOBER 1909 NUMBER 9

As announced in the October number of The Journal meetings are to be held in St. Louis on October 16 and in Boston on October 20. Professor Carpenter will again present his paper on high-pressure pumps at the former meeting, and at the latter will be given a paper on Reinforced Concrete Beams by Prof. Gaetano Lanza and Lawrence S. Smith. This paper is published in the current number of The Journal.

The next New York monthly meeting will be on Tuesday evening, November 9 when the paper on Reinforced Concrete Beams will again be presented. Prof. Walter Rautenstrauch of Columbia University will also present a paper, published in this number of The Journal, upon The Design of Curved Machine Members under Eccentric Load. These two papers with their discussion will cover thoroughly the subject of stresses in two important elements entering into structural work and machine members. The subject of reinforced concrete is of interest to a large proportion of the membership of the Society and the paper by Professor Rautenstrauch will be discussed by engineers engaged in machine design.

On Friday afternoon, October 8, was held a joint meeting of all the Standing Committees of the Society to consider the budget for the new fiscal year.

On Tuesday afternoon, October 12, the first meeting of the Council for 1909–1910 was held in the rooms of the Society, and in the evening the first New York meeting of the Society, with a paper by Prof. R. C. Carpenter upon The Pumps of the High-pressure Fire System of New York City.

ANNUAL MEETING

The annual meeting of The American Society of Mechanical Engineers will be held in the Engineering Societies' Building, New York, December 7 to 10. Papers are to be presented on electric driving, discussing the economic as well as the technical phases of the subject; upon apparatus for the measurement of flow of air, steam and water; and various miscellaneous subjects, including tests of lubricating oils and steam turbine nozzles, governing rolling mill engines, the use of moist fuels, boiler joints, pump valves, cast-iron test bars, etc. Full announcement will appear later.

RAILROAD TRANSPORTATION NOTICE

For members and guests attending the Annual Meeting in New York, December 7–10, 1909, the special rate of a fare and three-fifths for the round trip, on the certificate plan, is granted when the regular fare is 75 cents and upwards, from territory specified below.

a Buy your ticket at full fare for the going journey, between December 3 and 9 inclusive, and get a certificate, *not a receipt*, securing these at least half an hour before the departure of the train.

b Certificates are not kept at all stations. If your station agent has not certificates and through-tickets, he will tell you the nearest station where they can be obtained, Buy a local ticket to that point and there get your certificate and through-ticket.

c On arrival, present your certificate to S. Edgar Whitaker at headquarters, with 25 cents for validation. A certificate cannot be validated after December 10.

d An agent of the Trunk Line Association will validate certificates December 8, 9 and 10. No refund will be made on account of failure to have certificate validated.

e One hundred certificates must be presented for validation before the plan is operative. This makes it important to ask for certificate, and to turn it in at headquarters. Even though you may not use it this will help others to secure the reduced rate.

f If certificate is validated, a return ticket to destination can be purchased, up to December 14, on the same route over which the purchaser came, at three-fifths the rate.

This special rate is granted only for the following:

Trunk Line Association:

All of New York east of a line running from Buffalo to Salamanca, all of Pennsylvania east of the Ohio River, all of New Jersey, Delaware and Maryland; also that portion of West Virginia and Virginia north of a line running through Huntington, Charleston, White Sulphur Springs, Charlotteville, and Washington, D. C.

Central Passenger Association:

The portion of Illinois south of a line from Chicago through Peoria to Keokuk and east of the Mississippi River, the States of Indiana, and Ohio, the portion of Pennsylvania and New York north and west of the Ohio River, Salamanca and Buffalo, and that portion of Michigan between Lakes Michigan and Huron.

New England Passenger Association, except via Bangor and Aroostook R. R., Rutland R. R., N. Y. O. & W. R. R., Eastern Steamship Co. and Metropolitan Steamship Co.

Maine, New Hampshire, Vermont, Massachusetts, Rhode Island and Connecticut.

The Western Passenger Association offer revised one-way fares to Chicago, Peoria and St. Louis; these three places are points in the Central Passenger Association, and from these points purchase round trip tickets, in the manner outlined in the preceding paragraphs:

North Dakota, South Dakota, Nebraska, Kansas, Colorado, east of a north and south line through Denver, Iowa, Minnesota, Wisconsin, Missouri; north of a line through Kansas, Jefferson City and St. Louis, Illinois; north of a line from Chicago through Peoria to Keokuk.

Eastern Canadian Passenger Association:

Canadian territory east of and including Port Arthur, Sault Ste. Marie, Sarnia and Windsor, Ont.

JOINT COMMITTEE MEETING ON A STANDARD TONNAGE BASIS FOR REFRIGERATION

In November 1908 the Council of The American Society of Mechanical Engineers approved a recommendation that the Committee on a Standard Tonnage Basis for Refrigeration, already appointed, pre-

pare a joint report with a committee to be appointed by the American Society of Refrigerating Engineers on the same subject. The members of the committee appointed by The American Society of Mechanical Engineers are: Philip DeC. Ball, D. S. Jacobus, E. F. Miller, A. P. Trautwein and G. T. Voorhees. The committee appointed by the American Society of Refrigerating Engineers are: Louis Block, F. E. Matthews, W. E. Parsons, Thomas Shipley and John E. Starr, *Chairman.*

A meeting of the joint committee was not held for some little time as it was considered advisable to wait for the printed reports showing what had been done on the subject of recommending standard units at the meeting of the International Congress of Refrigerating Industries, held in Paris in October 1908. The first meeting of the joint committee was held at the rooms of The American Society of Mechanical Engineers September 29, 1909. There were present three members of the committee appointed by The American Society of Mechanical Engineers, and four members of the committee appointed by the American Society of Refrigerating Engineers. Dr. Jacobus was made chairman of the joint committee, and F. E. Matthews, Secretary.

The committee arranged to send out a circular letter to parties specially interested in refrigeration, requesting coöperation and inviting criticism on certain units proposed for measuring the cooling effect or refrigeration, and on a standard set of conditions for determining the tonnage capacity. Anyone interested will be gladly furnished with copies of this letter on communicating with F. E. Matthews, secretary of the joint committee, 29 West 39th Street, New York. A request was made that replies be sent before October 12, that the matter may be brought up at the meeting of the American Society of Refrigerating Engineers in Chicago October 18, but the committee will be glad to hear from anyone interested after that date.

DINNER TO SIR WILLIAM H. WHITE

On Monday evening, October 4, the President, past-presidents and members of the Council of The American Society of Mechanical Engineers gave a complimentary dinner to Sir William H. White, Honorary Member, Am.Soc.M.E. William Barclay Parsons, a personal friend of the guest of honor, and H. deB. Parsons, who represented the Council at the conference with the Institution of Mechanical

Engineers the past summer, in connection with the proposed joint meeting next year, were also present.

Sir William H. White is one of the most able naval architects and designers, having been director of naval construction and assistant controller of the royal navy (Great Britain) from 1885 to 1902, during which period he was the responsible designer for all the British warships. His most recent design was the Mauretania. In responding to the toast of the Institution of Mechanical Engineers, of which he is a past-president, he spoke of the cordial regard in which the institution holds the American society and of the delight with which they look forward to the joint meeting next year. The two associations are working hand in hand for the advancement of the interests of the mechanical engineering profession in both countries.

William Barclay Parsons, member of the Institution of Civil Engineers and of the American Society of Civil Engineers, in responding to a toast to the latter organization, said that he looked forward to the time when the engineering profession would represent more solidarity and that he believed, although there is a field for the specialist, that the profession as such should seek all possible opportunities for coöperation. An informal discussion then followed of the proper standards and qualifications for membership in engineering societies, and of engineering education, a subject to which Sir William White has contributed much time and attention as chairman of the Committee on Education and Training of Engineers appointed by the Institution of Civil Engineers. The report which was presented by this committee is the most exhaustive statement of the subject ever made.

Those present at the dinner were: President, Jesse M. Smith; Past-presidents, F. W. Taylor, Charles Wallace Hunt, F. R. Hutton and Ambrose Swasey; Members of the Council, R. C. Carpenter, F. M. Whyte, George M. Basford, Henry G. Stott, H. L. Gantt, William H. Wiley; Secretary, Calvin W. Rice; and the guests of the evening.

THE ENGINEERING SOCIETIES BUILDING FOR 1909

The following statistics of the engineering societies in the Engineering Building compiled by the Secretary of the United Engineering Society, Prof. F. R. Hutton, Past-President and Honorary Secretary, Am. Soc.M.E., are taken from the Proceedings of the American Institute of Electrical Engineers.

MEMBERSHIP OF SOCIETIES

Society	Membership
American Institute of Mining Engineers	4,300
The American Society of Mechanical Engineers	3,800
American Institute of Electrical Engineers	6,400
N. Y. Electrical Society	950
American Gas Institute	1,300
Electrical Manufacturers' Club	50
Wire Inspection Bureau	24
Empire State Gas and Electric Association	75
American Association of Electric Motor Manufacturers	200
National Electric Light Association	3,065
Museum of Safety and Sanitation	50
Association of Edison Illuminating Companies	68
Technical Society of New York	150
Explorers Club	110
Society of Naval Architects and Marine Engineers	870
American Street and Interurban Railway Association	1,000
Illuminating Engineering Society	1,065
Municipal Engineers of City of New York	565

ATTENDANCE AT MEETINGS

Society	No.	Attendance
American Institute of Mining Engineers	4	349
The American Society of Mechanical Engineers	14	5,393
American Institute of Electrical Engineers	11	3,745
New York Electrical Society	3	761
New York Railroad Club	9	3,774
New York Telephone Society	9	2,314
American Society of Heating and Ventilating Engineers	3	364
Blue Room Engineering Society	12	415
Explorers Club	9	472
German Scientific Club	3	183
Western Electric Club	5	507
Technical Society of New York	10	261
American Street and Interurban Railway Association	2	49
Municipal Engineers of New York	9	1,404
Illuminating Engineering Society	7	501
Society of Naval Architects and Marine Engineers	2	301
American Society of Refrigerating Engineers	3	291
Railway Signal Association	2	324
Cast Iron Fittings Manufacturers Association	6	102
Association of Edison Illuminating Companies	4	60
Empire State Gas and Electric Association	5	134
New York Electrical Trade School	1	262
American Gas Institute	3	1,344
American Society for Promotion of Industrial Education	1	203
American Railway Master Mechanics	1	57

STUDENT BRANCHES, AM. SOC. M. E.

The following table gives the Student Branches of the Society with their officers:

STUDENT BRANCH	AUTHORIZED BY COUNCIL	HONORARY CHAIRMAN	PRESIDENT	SECRETARY
	1908			
Stevens Inst. of Tech., Hoboken, N. J.	December 4	Alex. C. Humphreys	H. H. Haynes	R. H. Upson
Cornell University, Ithaca, N. Y.	December 4	R. C. Carpenter		C. F. Hirshfeld
	1909			
Armour Inst. of Tech. Chicago, Ill.	March 9	C. F. Gebhardt	N. J. Boughton	M. C. Shedd
Leland Stanford, Jr., University, Palo Alto, Cal.	March 9	W. F. Durand	P. H. Van Etten	H. L. Hess
Polytechnic Institute, Brooklyn, N. Y.	March 9	W. D. Ennis	J. M. Russell	P. Gianella
State Agri. College of Oregon, Corvallis, Ore.	March 9	Thos. M. Gardner	J. J. Karstetter	S. H. Graf
Purdue University, Lafayette, Ind.	March 9	L. V. Ludy	E. A. Kirk	J. R. Jackson
Univ. of Kansas, Lawrence, Kan.	March 9	P. F. Walker	H. S. Coleman	John Garver
New York Univ., New York.		C. E. Houghton		Andrew Hamilton
Univ. of Illinois, Urbana, Ill.		W. F. M. Goss	W. F. Colman	S. G. Wood
Penna. State College State College, Pa.				

THE SOCIETY'S HUDSON-FULTON EXHIBIT

Considerable interest was manifested in the Hudson-Fulton exhibit in the Council room of the Society. The total number of visitors who registered was 355, but 400 is a fair estimate of the total. The greatest registration for any one day was 52 on Monday, September 27.

A wide extent of territory was represented, including Connecticut, Delaware, Illinois, Maine, Massachusetts, Maryland, Michigan, Ohio, Pennsylvania, Rhode Island, Tennessee, Washington, D. C., Wisconsin, Canada, Japan and Switzerland.

In addition to the exhibits listed in the October Journal, Dr. Geo. F. Kunz has loaned a silver Hudson-Fulton medal and has presented to the Society the following:

Descriptive Guide to the Grounds, Buildings and Collections of the New York Botanical Garden.

List of Prints, Books, Manuscripts, etc., relating to Henry Hudson, the Hudson River, Robert Fulton and Steam Navigation, at the Lenox Branch of the New York Public Library.

The Indians of Manhattan Island and Vicinity, by Alanson Skinner, of the department of anthropology of the American Museum of Natural History.

The Wild Animals of Hudson's Day and the Zoölogical Park of our Day, by W. T. Hornaday, Sc.D., Director of the New York Zoölogical Park.

OTHER SOCIETIES

INTERNATIONAL SOCIETY FOR TESTING MATERIALS

Fully seven hundred delegates attended the fifth convention of the International Society for Testing Materials, held September 7–11, 1909, at Copenhagen, Denmark. The American members of that society in attendance were Dr. Charles B. Dudley, Mem.Am.-Soc.M.E., Altoona, Pa., official representative of the United States, Prof. Wm. K. Hatt, Lafayette, Ind., Richard L. Humphrey, Washington, D. C., Prof. Arthur N. Talbot, Urbana, Ill., Walter Wood, Mem.Am.Soc.M.E., Philadelphia, Pa., William R. Webster, Mem.-Am.Soc.M.E., Philadelphia, Pa., Tinius Olsen, Philadelphia, Pa., L. H. Fry, Mem.Am.Soc.M.E., Paris, technical representative in Europe of the Baldwin Locomotive Works, Prof. J. W. Richards, South Bethlehem, Pa., and Dr. Richard Moldenke, Mem.Am.Soc.M.E., Watchung, N. J. A very elaborate program was provided, beginning with an imposing ceremony in the great assembly hall of the University in the presence of all the members of the royal family.

Professor Heyn presented his report on the progress of metallography since the Brussels Congress, at the morning session of September 8, and in the afternoon William R. Webster, Mem.Am.-Soc.M.E., presented on behalf of International Committee No. 1 the specifications for iron and steel adopted respectively by America, England and Germany. The resolution was adopted in general and the committee instructed to continue the work of unification of iron and steel specifications. Geoige Lloyd of England presented a resolution in behalf of the cast-iron side of Committee No. 1, in which attention was called to the growing specifications of foundry pig iron by analysis. Dr. Richard Moldenke, Mem.Am.Soc.M.E., was called upon by the chair to explain the situation more fully. In addition the committee instructed Walter Wood, Mem.Am.Soc.-M.E., to gather the necessary information relative to the unification of cast-iron pipe specifications. The reports on the nomenclature of steel and iron and on specifications for copper were also presented, but the former was not accepted.

On the following day the proposed specifications for wrought-iron

pipe received a full discussion resulting in the establishment of a commission to study the relation of the wear of a material to its hardness. Dr. Moldenke then delivered the report of Commission 25 on Methods of Testing Cast Iron, explaining the progress made and urging international action on the purchase of pig iron by chemical specifications. Electric and magnetic properties of metals for testing purposes were next taken up and discussed. The closing session included the reports on tests for endurance and quality in copper wire and impact tests.

It was voted that the next congress be held in the United States in 1912 and the invitation of the American Society for Testing Materials was accepted. Dr. Charles B. Dudley, Mem.Am.Soc.M.E., was formally elected president of the society amid great enthusiasm. The congress then adjourned, after listening to a lecture by J. E. Stead on The Use of the Microscope in the Shop and Mill for Iron and Steel. An extended trip was taken into Jutland after the congress.

AMERICAN SOCIETY OF CIVIL ENGINEERS

At the regular fortnightly meeting of the American Society of Civil Engineers, October 6, papers were presented for discussion as follows: A Review of Chicago Paving Practice, by P. E. Green; The Purification of the Water Supply of Steelton, Pa., by James H. Fuertes.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

At a regular meeting of the Institute, held Friday evening, October 8, in the auditorium of the Engineering Societies Building, 29 West 39th Street, New York, a paper was presented by John B. Taylor, of the General Electric Company, Schenectady, N. Y., on Telegraph and Telephone Systems as Affected by Alternating-Current-Lines. At the November meeting, on the twelfth of that month, Dr. Cary T. Hutchinson, Mem.Am.Soc.M.E., will present a paper on The Electric System of the Great Northern Railway Company at Cascade Tunnel.

TECHNICAL SOCIETY OF BROOKLYN

In the first October meeting of the Technical Society of Brooklyn, President M. C. Budell presented his annual report. The election of officers for the coming year resulted as follows: M. C. Budell, President; Val. Wolz, Vice-President; H. Dann and A. Wittel, Sec-

retaries; Dr. W. Schad, Treasurer; E. Obermuller, Librarian; Bartholomew Viola, Mem.Am.Soc.M.E., Otto Sturm and J. Geo. Ament, chairmen of standing committees.

AËROPLANE FLIGHTS DURING THE HUDSON-FULTON CELEBRATION

A notable achievement in navigation of the air marked the closing days of the recent Hudson-Fulton celebration in New York. The aëronautic committee of the Hudson-Fulton Commission had contracted with Wilbur Wright and Glenn H. Curtiss for a series of aëroplane flights up the Hudson River.

Curtiss was unable to make any save short flights over the starting place, the parade ground of the army station at Governor's Island. On September 29, however, Wright encircled the Statue of Liberty in New York harbor and later made two circuits of the parade ground. On October 4, Wright sailed up the Hudson to Grant's tomb, encircled the foreign warships anchored at that point and returned over the river to Governor's Island. A flight over the city, planned for the afternoon of the same day, was not made owing to an accident to the engine. Further flights were not possible owing to Wright's Washington engagements. Curtiss essayed a flight early in the morning of September 29, but remained in the air less than a minute owing to a minor defect in the machine. Some difficulty was experienced in starting, as the wheels on which the machine was mounted sank into the sandy filling of the parade ground.

Wright's machine was fitted with a canoe, as shown in the illustration, in case of accident while over the water. The engine is started by turning the two 8-ft. propellers at the rear of the machine.

The flight around the Statue of Liberty started at 10.18 a.m. After leaving the monorail the machine made a gradual ascent, and at a height of forty feet made the circuit of the parade ground. Then re-circling it, the machine turned toward a point to the north of the statue. Passing within 20 ft. of the statue, which is 305 ft. high, the machine was seen to be at about the same height as the breast of the statue. After describing a figure 8 and flying over ships at anchor in the harbor, Wright turned his machine toward the Jersey shore for a short distance and then wheeled back to the starting point, having been in the air about seven minutes, covering a distance of six miles.

In the afternoon the machine encircled the parade ground twice, traveling against the wind at a speed of about forty miles and with the wind at about fifty-seven miles. At no time did the wind exceed ten miles an hour.

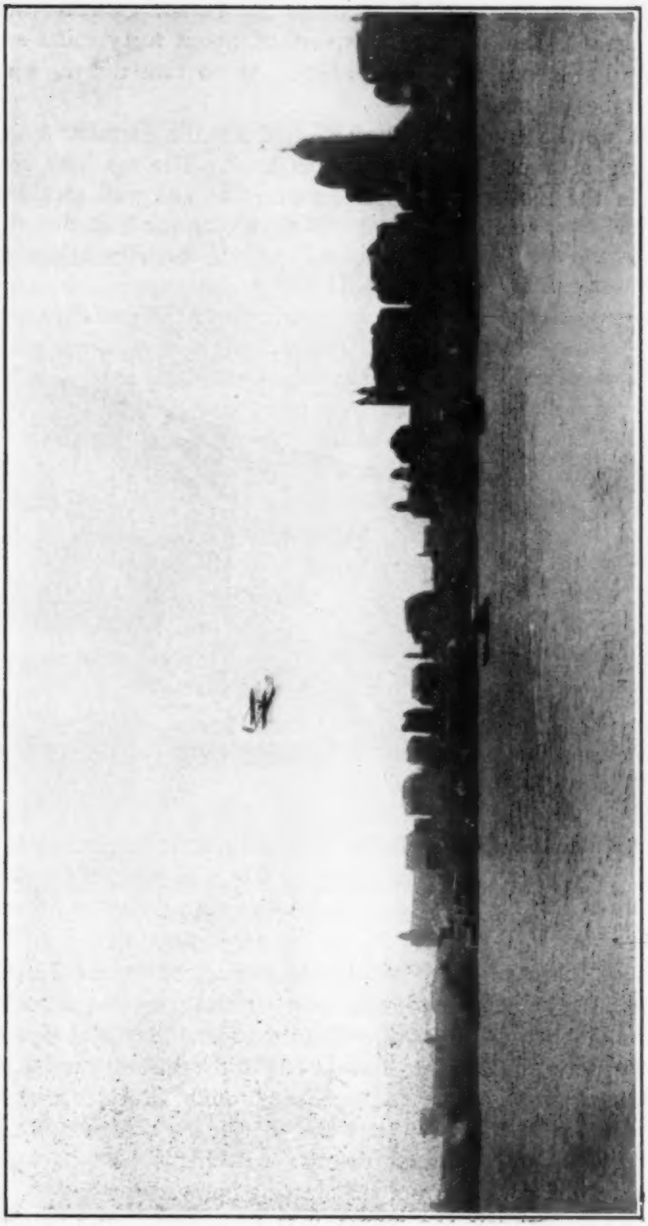
The flight up the Hudson started at 9.56 a.m. on October 4, the wind blowing at about twelve miles an hour. The machine rose rapidly from the monorail and passed over the sea wall at about forty or fifty feet heading toward the mouth of the Hudson. To avoid trouble with air currents caused by the high buildings on

WILBUR WRIGHT STANDING BESIDE HIS AËROPLANE. THE CANOE IS CARRIED IN CASE OF ACCIDENT WHILE OVER THE WATER

the New York side of the river, Wright flew close to the Jersey shore, saluted by shrieking whistles and cheering spectators. At one point the height was about three hundred feet. At 130th Street Wright turned the machine in a wide circle to retrace his path.

During the return flight the machine was brought down to within about fifty feet of the water, afterward soaring to a higher level. When near the island a gradual descent was made, the machine landing about twenty yards from the starting point.

The aëroplane had left the monorail at 9.56 o'clock and landed at 10.29 to 10.33 o'clock, so that the time in the air was 33 min.



The Wright Aëroplane Flying over the Hudson River on the Return Trip from Grant's Tomb to Governor's Island

33 sec. The distance in a straight line is 18.3 miles, but the actual distance traveled was nearer twenty-four miles. The average speed was approximately $45\frac{1}{2}$ miles an hour and the average altitude 200 ft.

NECROLOGY

THOMAS HALLETT BRIGGS

Thomas Hallett Briggs was born on August 21, 1870 in New York. He received his education in the public schools of Brooklyn, N. Y., and finished with a technical course at Cooper Union. During his studies at Cooper Union, he was employed in the drafting room of the Logan Iron Works of Brooklyn, with which company he remained for fourteen years. His work there covered not only drafting-room work, but shop inspection, and he finally became outside representative. He became associated wth the M. H. Treadwell Co., New York, as salesman, in 1904, which position he held until the time of his death on September 24, 1909. Mr. Briggs was a member of the Society of Gas Engineers, and entered this Society as an Associate in 1900.

PERSONALS OF THE MEMBERSHIP AM. SOC. M. E.

Kilburn E. Adams has severed his connection with the Wm. Underwood Co., and has accepted the position of mechanical engineer with the Boston & Albany Railroad, Boston, Mass.

Charles M. Allen, professor of experimental mechanical engineering in Worcester Polytechnic Institute, has been appointed professor of hydraulic engineering in the same institution.

A. Bement has been appointed a member of a committee named by the Western Society of Engineers, to coöperate with the Chicago Harbor Commission.

At the regular meeting of the Engineers' Club of St. Louis, Wednesday evening, October 12, William H. Bryan, Mem.Am.Soc.M.E., presented a paper on Going Value as an Element in the Appraisal of Public Utilities.

Philip L. Clarke has resigned his position in the experimental turbine department of the General Electric Co., Schenectady, N. Y., and is now in the employ of White & Newcomb of Mexico City.

Claude E. Cox has resigned his position as engineer and assistant manager of the Interstate Automobile Co., Anderson, Ind., and has assumed a similar position with the Wilcox Motor Car Co., Minneapolis, Minn.

Arthur M. Dean, formerly in the employ of the Mora Motor Car Co., Newark, N. Y., has accepted a position with the Matheson Motor Car Co., Wilkes-Barre, Pa.

Harrington Emerson is the author of a book on Efficiency as a Basis for Operation and Wages.

William D. Ennis has contributed an article on Materials for Pipe Lines to the September 21 issue of *Power and the Engineer*.

Carl E. Hardy, recently located at Cartersville, Ga., has been made assistant superintendent of shops, manufacturing department, U. S. Navy Yard, Mare Island, Cal.

Edward J. Kunze, formerly consulting engineer, Newark, N. J., has been appointed instructor in steam and gas engineering, University of Wisconsin, Madison, Wis.

H. B. MacFarland, formerly consulting engineer, Chicago, Ill., has been appointed engineer of tests, Atchison, Topeka & Sante Fe Railway Co., Topeka, Kansas.

F. W. Mahl has become associated with the Union Pacific System and Southern Pacific Co., Chicago, Ill. He was formerly in the employ of the Colorado and Southern Railway Co., Denver Colo., as mechanical engineer and general purchasing agent.

M. C. Maxwell, of the department of applied mechanics, Pratt Institute, delivered the opening address before the Modern Science Club of Brooklyn, N. Y., October 5.

Harry de B. Parsons delivered the address on the occasion of the Hudson-Fulton celebration of the Clarkson School of Technology, on the evening of September 29, entitled, A Sketch of the Commercial Development during the Last Three Hundred Years, 1609–1909.

Arthur W. Richter, professor of experimental engineering, University of Wisconsin, has been appointed dean of the college of engineering of the University of Montana, Helena, Mont.

H. W. Rowley, until recently sales engineer of the New York office of the Allis-Chalmers Co., has opened an office as special representative for that company in the Evans Building, Washington, D. C.

William E. Smith has accepted a position with the Babcock & Wilcox Co., Barberton, O. He was until recently connected with the Delaware, Lackawanna & Western Railroad Co., Scranton, Pa.

E. R. Stoughton has entered the service of Baird & West, Detroit, Mich. He was recently associated with the U. S. Heater Co., Detroit, Mich.

Robert I. Todd, vice-president of the Terre Haute, Indianapolis & Eastern Traction Co., has been made general manager. Mr. Todd is also vice-president and general manager of the Indianapolis Traction and Terminal Co.

A. F. Van Deinse, who recently completed the installation of a power plant for the El Tiro Copper Co., Silverbell, Ariz., has accepted a position with the Westinghouse Electric and Manufacturing Co., and will be located at their El Paso, Texas, office..

H. H. Vaughan presented a paper on Locomotive Counter-balancing at the September 7 meeting of the Canadian Railway Club.

THE JOURNAL

OF

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

VOL. 31 NOVEMBER 1909 NUMBER 10

THE next New York monthly meeting will be held on Tuesday evening, November 9. Two papers will be presented, one by Prof. Gaetano Lanza of the Massachusetts Institute of Technology on Reinforced Concrete Beams, the other by Prof. Walter Rautenstrauch of Columbia University, on The Design of Curved Machine Members under Eccentric Load. The paper by Professor Lanza will be illustrated by lantern slides showing methods of testing full-sized beams. The paper by Professor Rautenstrauch will be discussed by authorities on machine design.

On Saturday evening, November 13, The American Society of Mechanical Engineers and the Engineers' Club of St. Louis will meet together in the rooms of the Engineers' Club, 3817 Olive Street, St. Louis. A paper will be presented upon A Modern Boiler Shop, by E. R. Fish, Secretary of the Heine Safety Boiler Co., St. Louis.

In Boston, a meeting will be held Wednesday evening, November 17, with a topical discussion on Low-Pressure Steam Turbines. This discussion will be participated in by W. L. R. Emmet, General Electric Co., Schenectady, N. Y.; H. G. Stott, Interborough Rapid Transit Co., New York; Richard H. Rice, General Electric Co., West Lynn, Mass.; Prof. Edward F. Miller, Massachusetts Institute of Technology, and others.

ANNUAL MEETING

The annual meeting of The American Society of Mechanical Engineers will be held in the Engineering Societies' Building, New York,

December 7 to 10. The arrangements for the meeting are now being completed by the Meetings Committee and a fuller announcement will be made in a later issue of The Journal.

SOCIAL FEATURES OF THE ANNUAL MEETING

A meeting of the members resident in and about the city of New York was held in the rooms of the Society on the evening of Tuesday, October 19, to discuss ways and means for the reception of the members at the time of the annual meeting in return for courtesies when attending the conventions in other cities.

The meeting was called to order by the President, who was chosen chairman. After explaining the object of the meeting and the rule passed by the Council last winter, placing in the hands of the members the full charge and responsibility for the social features, the President called for nominations for chairman of the local committee, and William D. Hoxie was unanimously elected with authority to appoint a local reception committee. An informal discussion followed in regard to the conduct of the annual meeting and many helpful suggestions were obtained.

RAILROAD TRANSPORTATION NOTICE

For members and guests attending the Annual Meeting in New York, December 7-10, 1909, the special rate of a fare and three-fifths for the round trip, on the certificate plan, is granted when the regular fare is 75 cents and upwards, from territory specified below.

a Buy your ticket at full fare for the going journey, between December 3 and 9 inclusive, and get a certificate, *not a receipt*, securing these at least half an hour before the departure of the train.

b Certificates are not kept at all stations. If your station agent has not certificates and through tickets, he will tell you the nearest station where they can be obtained, Buy a local ticket to that point and there get your certificate and through ticket.

c On arrival, present your certificate to S. Edgar Whitaker at headquarters, with 25 cents for validation. A certificate cannot be validated after December 10.

d An agent of the Trunk Line Association will validate certificates December 8, 9 and 10. No refund will be made on account of failure to have certificate validated.

e One hundred certificates must be presented for validation before the plan is operative. This makes it important to ask for certificate, and to turn it in at headquarters. Even though you may not use it this will help others to secure the reduced rate.

f If certificate is validated, a return ticket to destination can be purchased, up to December 14, on the same route over which the purchaser came, at three-fifths the rate.

This special rate is granted only for the following:

Trunk Line Association:

All of New York east of a line running from Buffalo to Salamanca, all of Pennsylvania east of the Ohio River, all of New Jersey, Delaware and Maryland; also that portion of West Virginia and Virginia north of a line running through Huntington, Charleston, White Sulphur Springs, Charlotteville, and Washington, D. C.

Central Passenger Association:

The portion of Illinois south of a line from Chicago through Peoria to Keokuk and east of the Mississippi River, the States of Indiana, and Ohio, the portion of Pennsylvania and New York north and west of the Ohio River, Salamanca and Buffalo, and that portion of Michigan between Lakes Michigan and Huron.

New England Passenger Association, except via Bangor and Aroostook R. R., Rutland R. R., N. Y. O. & W. R. R., Eastern Steamship Co. and Metropolitan Steamship Co.

Maine, New Hampshire, Vermont, Massachusetts, Rhode Island and Connecticut.

The Western Passenger Association offer revised one-way fares to Chicago, Peoria and St. Louis; these three places are points in the Central Passenger Association, and from these points purchase round trip tickets, in the manner outlined in the preceding paragraphs:

North Dakota, South Dakota, Nebraska, Kansas, Colorado, east of a north and south line through Denver, Iowa, Minnesota, Wisconsin, Missouri; north of a line through Kansas, Jefferson City and St. Louis, Illinois; north of a line from Chicago through Peoria to Keokuk.

Eastern Canadian Passenger Association:

Canadian territory east of and including Port Arthur, Sault Ste. Marie, Sarnia and Windsor, Ont.

MEETING IN GREAT BRITAIN

JOINT MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS AND THE INSTITUTION OF MECHANICAL ENGINEERS

The Society has received an invitation from The Institution of Mechanical Engineers of Great Britain to hold a joint meeting with them in the Summer of 1910. The letter of invitation and President Smith's reply follow:

THE INSTITUTION OF MECHANICAL ENGINEERS
Storey's Gate, St. James Park, Westminster, S. W.
17th September, 1909.

Dear Mr. President:

At a Meeting of the Council of this Institution held today, the following Resolution was unanimously passed:

"That a very hearty invitation be sent to The American Society of Mechanical Engineers to participate in a Joint Meeting in England with the Institution of Mechanical Engineers, and that the Meeting be held in the Summer of 1910, if possible during the last week in July."

I need scarcely say how warmly the subject was supported by those present, especially as the Council had learnt from the Committee appointed to confer with Mr. H. deB. Parsons, the special representative of your Society, the cordiality with which the idea had been taken up by your Members.

We hope that we may be favored with the presence of yourself, your Council, and many of your Members at the proposed Meeting.

With all good wishes, we are,

Yours very truly,
JOHN A. F. ASPINALL
President
EDGAR WORTHINGTON
Secretary

The President
The American Society of Mechanical Engineers
29 West 39th Street, New York, U. S. A.

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
29 West 39th Street, New York, U. S. A.

Dear Mr. President:

The Council of The American Society of Mechanical Engineers has considered the very cordial invitation of The Institution of Mechanical Engineers, to hold a joint meeting in England in the summer of 1910, conveyed by your letter of September 17.

The Council was unanimous in the acceptance of the invitation and bids me convey to you its action as follows:

"Resolved,—That The American Society of Mechanical Engineers accept the very cordial invitation of The Institution of Mechanical Engineers, to hold a joint meeting in England in the Summer of 1910. The Council feels that the interests of Engineering throughout the World will assuredly be advanced by the giving and the acceptance of this invitation;—an evidence of an increasing coöperation among the various societies representing the Profession of Engineering."

In conveying this resolution of the Council permit us to inform you of the universal cordiality with which the invitation has been received both by the Council and by the Members of the Society. It is the expectation that a representative delegation of the Society will be present at the meeting.

Please accept our expressions of sincere good will.

Jesse M. Smith
President
Calvin W. Rice
Secretary

To The President
The Institution of Mechanical Engineers
London, England

Fuller details of the meeting will be sent out shortly to the entire membership, with reply cards, to enable the Executive Committee who have the matter in hand to estimate the number of members who may possibly wish to participate in this extraordinary opportunity for professional and social meetings with a sister society.

The meetings will begin July 26, and conclude on July 29.

Interesting special exhibitions are to take place in Brussels, Düsseldorf and other cities, and the Passion Play will be produced next year at Oberammergau, for the first time in ten years.

A considerable number of the representative members of the Society and ladies have already signified their intention of going, so that the undertaking is now an assured success.

OCTOBER MEETINGS OF THE SOCIETY

NEW YORK, OCTOBER 12

At the meeting of the Society held October 12 in the lecture room on the fifth floor of the Engineering Societies' Building, Prof. R. C. Carpenter presented his paper on The High-Pressure Fire-Service Pumps of Manhattan Borough, City of New York. Pres. Jesse M. Smith presided. The attendance was 192.

Secretary Calvin W. Rice announced the meetings of the Society in St. Louis on October 16 and in Boston on October 20, and the invitation of the Institution of Mechanical Engineers to hold a joint session with them from July 26 to July 29, 1910. The President then introduced the following Japanese commissioners visiting the United States to study various industries: Dr. Ryota Hara, doctor of engineering and chief engineer of Yokohama; Rinnosuke Hara, of the Japanese Architectural Society; Junkichi Tanabe, of Tokyo, of the Institute of Japanese Architects; and Narazo Takatsuji, director of a large spinning factory. A telegram of regret was received from Kojiro Matsukata, the leading shipbuilder of Japan.

So large a number of the members identified with the centrifugal pump industry had manifested a desire to discuss the paper that the pump feature of the paper was emphasized. Those participating in the discussion are considered authorities in the design and operation of centrifugal pumps and many interesting facts were brought out in regard to the efficiency of the New York fire pumps and of centrifugal pumps in general. Representatives from the department of water supply, gas and electricity also contributed to the interest of the discussion, speaking from the standpoint of reliability and of distribution.

Those taking part in the discussion were: Prof. Geo. F. Sever, William M. White, Geo. L. Fowler, John H. Norris, J. R. Bibbins, J. J. Brown, Geo. A. Orrok, Frederick Ray, H. Y. Haden, Thos. J. Gannon, Henry B. Machen, Richard H. Rice, Chas. A. Hague. Written discussions were submitted by: A. C. Paulsmeier, Prof. W. B Gregory, Wm. O. Webber and Chas. B. Rearick.

At the close of the discussion Mr. White showed a number of lantern slides giving efficiency curves of various pumps designed by the I. P. Morris Co., Philadelphia, Pa.

Mr. Fowler, with the aid of lantern slides, described the work of centrifugal pumps in dredging, and exhibited the following as evidence of the great suction capacity of these pumps:

A piece of shaft weighing 70 lb. raised and passed by a 15-in. dredging pump; improvement of New York Harbor, Steamer Reliance.

A piece of tree root raised and passed by a 12-in. pump from 14 ft. of water at Miami, Fla.; Florida East Coast Railway Company improvements.

A piece of pig iron measuring $11\frac{1}{2}$ in. by $4\frac{3}{4}$ in. by $3\frac{1}{4}$ in. and weighing 35 lb., raised and passed by a 8-in. special cataract wrecking pump from 15 ft. of water from the wreck of a canal boat sunk at Puas Dock, Yonkers, N. Y., by the Baxter Wrecking Company, New York.

MEETING, AM. SOC. M. E., ENGINEERS' CLUB OF ST. LOUIS, ST. LOUIS, OCTOBER 16

The first meeting of the two societies was held at the rooms of the Engineers' Club of St. Louis at 8.15, Saturday evening, October 16, under the direction of William H. Bryan, Chairman, M. L. Holman and E. L. Ohle, Secretary, of the local joint committee.

A letter from President Jesse M. Smith was presented, indicating the sentiment of the Society towards local meetings. This was responded to briefly by President E. E. Wall, of the Engineers' Club of St. Louis, who reciprocated the sentiments of President Smith, and emphasized his belief in the advantages of coöperation.

Prof. R. C. Carpenter of Cornell then presented in abstract his paper on The High-Pressure Fire-Service Pumps of Manhattan Borough, City of New York, accompanying it by running comments and comparisons.

He was followed by Horace S. Baker, Assistant Engineer of the City of Chicago, who presented the results of recent study with a view of adopting high-pressure service. His talk was illustrated. E. E. Wall, assistant water commissioner, City of St. Louis, outlined the plan proposed for high-pressure fire service in St. Louis. He was followed by H. C. Henley, chief inspector, St.Louis fire prevention bureau, and vice-president of the National Fire Protection Association, expressing views of the fire insurance authorities, entirely favorable to the installation of such systems when properly designed and operated. Chas E. Swingley, chief of the St. Louis fire department, on invitation, responded briefly to the effect that such systems were of

undoubted advantage in the congested districts of large cities, and expressed the hope that something might be done soon along this line in St. Louis. There was further brief discussion by Edw. Flad, Prof. W. H. Hibbard, and H. C. Toensfeldt.

Luncheon was served by the Engineers' Club of St. Louis. The attendance was 100.

MEETING AM.SOC.M.E., BOSTON SOCIETY OF CIVIL ENGINEERS, BOSTON, OCTOBER 20

On Wednesday evening, October 20, a joint meeting of the Society with the Boston Society of Civil Engineers was held in the latter society's rooms, Tremont Temple, Boston, Mass.

Chas. T. Main, vice-president of the Boston Society of Civil Engineers, presided. Following the routine business of the Society of Civil Engineers, Mr. Main read a letter from Jesse M. Smith, President of The American Society of Mechanical Engineers, regretting that he could not be present at the meeting, and wishing the Boston members success for their coming meetings. An announcement was also read of the next meeting in Boston of The American Society of Mechanical Engineers, to be held in Room 6 of the Lowell Building, Massachusetts Institute of Technology, November 17; full announcement appears elsewhere in The Journal.

A paper by Gaetano Lanza, professor, and Lawrence F. Smith, instructor at the Massachusetts Institute of Technology, on Stresses in Reinforced Concrete Beams, was read by the former. Following the presentation of the paper, a discussion by J. R. Worcester was read in his absence by Mr. Tinkham, Secretary of the Society of Civil Engineers. Sanford Thompson, Fred S. Hines, Henry Bryant and Geo. F. Swain contributed oral discussions.

The total attendance at the meeting was 180, of whom 60 were members of the Society of Civil Engineers, 50 were members of The American Society of Mechanical Engineers and 70 were guests.

MEETING OF THE COUNCIL

A meeting of the Council was held on October 12, 1909, in the rooms of the Society, Jesse M. Smith, President, presiding. There were present: Messrs. Breckenridge, Carpenter, Gantt, Sando, Humphries, Hunt, Miller, Moultrop, Waitt, Whyte and the Secretary. A letter of regret was received from G. M. Basford.

The deaths of the following were reported; Archibald W. Blair, T. Hallett Briggs, Robert Hoe, R. B. Lincoln, George W. West.

The following resignations were accepted: R. T. Close, Samuel G. Colt, H. Harcourt Dixon, Wm. L. Draper, Walter Flint, T. A. Hilles, Edmund Kent, W. P. Norton, F. J. Plummer, Edward L. Ross, Lucien N. Sullivan.

The Council confirmed the appointment of Honorary Vice-Presidents as follows: National Conservation Congress, Seattle, Wash., R. M. Dyer, M. K. Rodgers, W. F. Zimmermann; American Mining Congress, Goldfield, Nev., Dr. J. A. Holmes.

Japanese Honorary Commercial Commission. The President reported that he and the Secretary had called upon the Japanese Honorary Commercial Commission and extended to them the courtesies of the Library and the rooms of the Society and that he had invited the engineer members of the Commission to attend the meeting of the Society that evening.

EXECUTIVE COMMITTEE

Professional records, September 1909. The Council approved of the applications for membership as shown in the professional service sheet of September 1909 and under By-Law 2 gave specific approval of the following applicants who do not live in the United States: Arthur N. Blum, Luis Alberto Carbo, Louis Edward Polhemus, Henry Terry Purdy, Mark Robinson.

COMMITTEE ON CONSTITUTION AND BY-LAWS

The following amendments recommended by the Committee on Constitution and By-Laws were approved:

Trustee of the United Engineering Society:

B– The Council shall, previous to January 1 of each year, elect a trustee to serve for a term of three years on the Board of Trustees of the United Engineering Society. No trustee shall be eligible for more than two years consecutively.

Expenses of Section Meetings:

R24 Expenditures for the purposes of a section chargeable to the Society shall be authorized by the Secretary of the Society before they are incurred, and must be provided for in the estimate and budget of the Committee on Meetings. No liability otherwise incurred shall be binding on the Society. Any expenditure not so provided shall be met by the section itself.

The Journal:

B– The Council shall institute a monthly publication to be called "The Journal," which shall be under the management of the Secretary, who shall act under the general supervision of the Publication Committee, subject to approval by the Council as to the policy thereof and the expenditures therefor. The annual subscription price of The Journal to each member is five dollars, and is included in the annual dues of such member.

Election of members:

B6 The Secretary shall mail at least thirty days in advance of each annual or semi-annual meeting to each member entitled to vote, a ballot stating the names and the respective grades of the candidates for membership in the Society which have been approved by the Council, and the time of the closure of the voting. The voter shall prepare his ballot by crossing out the name of any candidate rejected by him, and shall enclose said ballot in an envelope and seal the same; he shall then enclose said envelope in a second envelope marked "Ballot for Members," and seal the same, and he shall then write his own name thereon for identification. The ballot thus prepared and enclosed shall be mailed or delivered unopened to the tellers of election. The Secretary shall certify to the competency and the signature of all voters. A ballot without the autographic endorsement of the voter written on the outer envelope is defective, and shall be rejected by the tellers of election.

B7 The voting for the election of members shall close at twelve o'clock noon five days in advance of the day on which the annual or semi-annual meeting begins. The tellers of election shall first open and destroy the outer envelopes, and shall then open the inner envelopes and canvas the ballot, and certify the result to the President or presiding officer of the Society, at the first session of the current meeting of the Society. The tellers shall not receive any ballot after the stated time for the closure of the voting.

Election of Officers:

B12 The Secretary shall mail on or before the last Thursday in October of each year to each member entitled to vote, a ballot stating the names of the candidates for the several offices falling vacant, and the time of the closure of the voting. The voter shall prepare his ballot by crossing out the name of any candidate or candidates rejected by him, and may write in the name of any eligible member of the Society. The voter shall enclose said ballot in an envelope and seal the same. He shall then enclose the sealed envelope in a second envelope marked "Ballot for Officers," seal the same, and shall then write his name thereon for identification. The ballot thus prepared and enclosed shall be mailed or delivered unopened to the tellers of election. The Secretary shall certify to the competency and signature of all voters. A ballot without autographic endorsement of the voter written on the outside envelope is defective, and shall be rejected by the tellers of election. A ballot which contains more names than there are offices to be filled is thereby defective, and shall be rejected by the tellers.

B13 The voting for the election of officers shall close at twelve o'clock noon on the Thursday preceding the first Tuesday of December in each year. The

tellers shall not receive any ballot after the stated time for the closure of the voting. The tellers of election shall first open and destroy the outer envelopes and shall then open the inner ones, canvass the ballots and certify the result to the President, at the first session of the current meeting of the Society. The presiding officer shall then announce the candidates having the greatest number of votes for their respective offices, and declare them elected for the ensuing year.

B34 The President shall on or before the last Thursday in October of each year, appoint three tellers of election of officers, whose duty shall be to canvass the votes cast, and certify the same to the President at the first session of the annual meeting. Their term of office shall terminate when their report of the canvass has been presented and accepted.

Library of the Society:

R16 The Library of the Society shall be conducted as a free public reference library of engineering and the allied arts and sciences. It shall be open on all week days between the hours of 9 a.m. and 9 p.m., except New Year's, Independence, Thanksgiving and Christmas days. The rooms of the Society shall be open for the use and the convenience of members during the usual business hours.

Library Committee:

B27 The Library Committee shall consist of five persons who shall be Members, Associates or Juniors. The term of office of one member of the Committee shall expire at the end of each annual meeting. It shall be the duty of the Library Committee to coöperate with similar committees of the American Institute of Electrical Engineers and the American Institute of Mining Engineers, in the care and development of a library. At the end of each fiscal year the committee shall deliver to the Secretary a detailed report of its work.

House Committee:

B28 The House Committee shall consist of five persons who shall be Members, Associates or Juniors. The term of office of one member of the Committee shall expire at the end of each annual meeting. It shall be the duty of the House Committee to have the care, management and maintenance of the Rooms of the Society and furnishings, the historical relics, the paintings, and objects of art, and to recommend to the Council suitable regulations for their care and use. At the end of each fiscal year, the committee shall deliver to the Secretary a detailed report of its work.

Author's Copies:

The Secretary may furnish to the author twerty copies of his paper without charge. The Secretary may furnish to the technical press such papers as they may wish to publish which have been published in The Journal.

Fees:

B18 The initiation fees and annual dues of the first year shall be due and payable on notice of election to membership, and upon that payment the member

shall be entitled to the Transactions for the year. Thereafter the annual dues shall be due and payable on the first day of October in each year for the ensuing twelve months.

B19 A member in arrears for dues for one year shall not be entitled to vote. Should the right to vote be questioned, the books of the Society shall be conclusive evidence. The resignation of a Member indebted to the Society shall not be accepted.

Voted: To approve the following directions to the Secretary:

That the Secretary be instructed to print on each ballot the date of closure of voting, and a reference to the By-Law that the ballot will not be canvassed if not received at that time, and to include a statement urging every member to cast a vote.

That the Secretary shall mail on or before the last Thursday of October of each year to each member entitled to vote, a ballot stating the names of the several candidates for offices proposed for election by the Nominating Committee or committees, and specifying the number of officers to be elected and the time of the closure of the voting.

Revision of the Constitution

Voted: That when final action on the Constitution and By-Laws is taken, the necessary re-arrangement, re-numbering, etc., be made.

Voted: To request the Committee on Constitution and By-Laws to go over the entire Constitution and By-Laws and also the amendments considered above and in such places where there is a distinction made between President and Presiding Officers, the Committee rephrase the language to make it consistent and report to the Council at the next meeting.

FINANCE COMMITTEE

Voted: To approve the following motions from the Minutes of the Finance Committee, October 1909:

"*Voted:* The Finance Committee recommend to the Council that transfers be made of unexpended appropriations and also additional appropriations according to attached list, to meet the excess in expenditures of the various committees for the fiscal year ending September 30, 1909, these appropriations all being within the current income for the year, leaving a total unexpended and unappropriated income of $1,639.18.

"*Voted:* That the excess of current income ($1,639.18) over current expense for the fiscal year 1908–1909 be applied to the reduction of the account, Advances Preliminary to Advertising."

Voted: To cancel the unexpended appropriation of the Increase of Membership Committee, $368.48, and the Library Committee, $464.16, by crediting the same to the appropriations for the other committees.

Voted: To approve the additional appropriations to the amount of $10,734,99, the same being within the income of the Society, for the work of the year just closed, as follows:

Finance Committee	$2012.27	
Membership Committee	392.36	
House Committee	390.76	
Meetings Committee	759.73	
Publication Committee	4099.68	
Research Committee	0.58	
Sales—Expenditures	3901.00	
Committee on Power Tests	11.25	
		$11,567.63
Available Balances:		
Increase of Membership Committee	368.48	
Library Committee	464.16	832.64
Appropriation required		$10,734.99
Total unappropriated income		12,374.17
Excess of income over expenditures		1,639.18

Budget for 1910. The budget for the fiscal year 1909–1910 as recommended by the Finance Committee was approved by the Council as follows:

Current Income estimate 1909–10		Current Expense	
Dues Current	$50,000	Finance Committee	$26,000
Dues arrears	2,000	Membership Committee	2,400
Reserve fund, 10 per cent	3,400	Increase Committee	500
Sales gross receipts	5,000	House Committee	1,150
Interest	2,200	Library Committee	2,880
Advertising	21,000	Meetings Committee	8,050
		Publication Committee	34,900
		Research Committee	500
	$83,600	Executive Committee	600
		Committee on Power Tests	500
		Sales Expenditures	3,000
			$80,480
Excess of income over expenses			3,120
			$83,600

Voted: To adopt the recommendation of the Finance Committee as follows: That Finance Committee be requested to investigate the financial situation of the Society and make a report to the Council.

MEMBERSHIP COMMITTEE

Voted: To approve under C16, upon the request of Herbert J. White and the recommendation of the Membership Committee, the placing of his name again on the ballot for membership, for the annual meeting 1909.

Voted: To approve the request of July 28, 1909, of F. W. Jackson, as approved by the Membership Committee, for reinstatement in the Society, to date from October 1, 1909.

JOHN STEVENS' PART IN THE DEVELOPMENT OF STEAM NAVIGATION

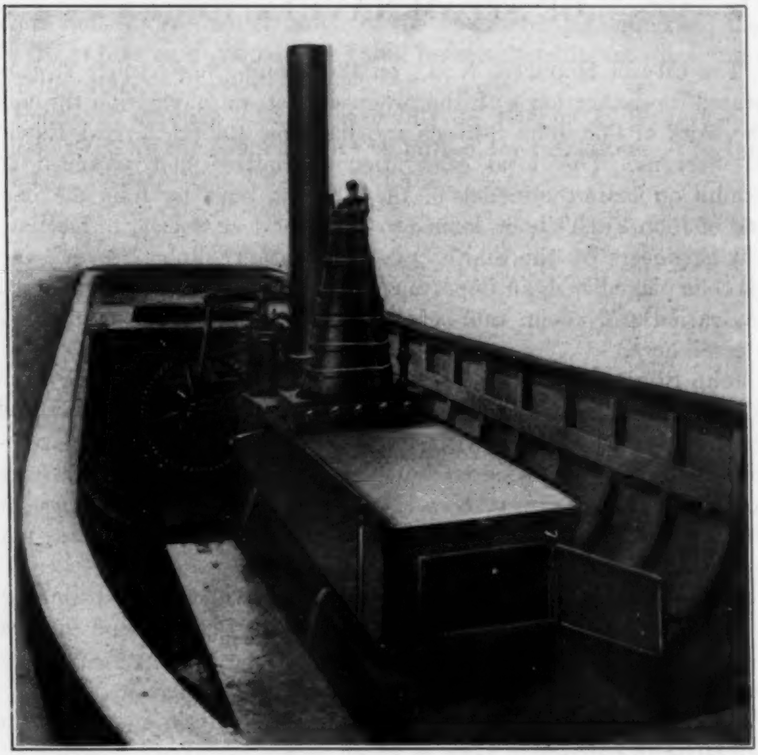
The City of Hoboken, N. J., on the evening of October 7, celebrated its connection with the progress in steam navigation through the work of Col. John Stevens and his sons, Robert L. and Edwin A. Stevens. The local celebration committee had arranged to exhibit on floats the models of the Phœnix, built by John Stevens, and of John Fitch's boat, loaned to The American Society of Mechanical Engineers by the Smithsonian Institution. John Stevens and his sons played such an important part in the development of steam navigation and steam railroads that a brief history of their work is given here.

John Stevens was born in New York in 1749. Graduating from Kings College, now Columbia University, in 1768, he studied law and was admitted to the bar. He served with distinction in the Revolution and was at one time treasurer of New York state. His winter home was on Broadway, New York, and his summer residence at Hoboken, N. J., then an island. Having ample means, he was not hampered in his steamboat experiments.

One writer states that Stevens was first attracted to steamboat development when he saw Fitch's boat on the Collect Pond in New York City in 1796. Another writer places the time in 1787, when Stevens saw Fitch's boat on the Delaware near Burlington, N. J.

That he also followed Rumsey's experiments with interest is shown by a letter to Rumsey in 1788, in which he writes: "Your invention of generating steam by means of a worm is certainly of the utmost importance, but more particularly when applied to the purposes of navigation." Stevens then describes a boiler to be formed of a helix of copper pipe, suspended in a cylindrical stove, the turns of the helix to lie close so as to prevent air and smoke passing between them. From the top of the "worm" a flue extended 12 or 18 in. above the stove. Fuel was placed on a grate in the upper part of the stove, around the flue. The path of the air was downward through the fire, the gases passing around the worm to the bottom of the stove and up the inside and through the flue.

On January 9, 1789, Stevens applied to the New York legislature for "an exclusive privilege to build steamboats on a plan lately by him invented." In his petition he said that "to the best of his knowledge and Belief, his Scheme is altogether new, or at least does not interfere with the Inventions of either of the Gentlemen (probably Fitch and Rumsey) who have applied . . . . for an exclusive



TWIN-SCREW ENGINE AND BOILER BUILT BY COL. JOHN STEVENS IN 1804.
VIEW TAKEN FROM NEAR THE BOW LOOKING TOWARD THE STERN

Right of navigating by means of Steam." He prays "That in case his machine should appear to be a new and useful Invention that the Honorable the Legislature would be pleased to grant to him an exclusive privilege and Right of using the same for the purpose of navigation throughout the State of New York for such terms of Years as shall seem meet."

The petition was read and referred to the committee considering Rumsey's petition for a monopoly which had been filed previously. Rumsey's petition was granted, doubtless solely on the fact of priority of presentation.

In 1790 John Stevens petitioned Congress for the formulation of a patent law, and it was on this petition, says Dr. J. E. Watkins, that the law of 1790, the foundation of the American patent system, was framed.

In 1792 Stevens took out patents for propelling vessels by steam pumps modified from the original steam pumps of Savary. In 1798 an experimental boat of 30 tons was tried on the Passaic River, in New Jersey, "a horizontal centrifugal wheel drawing water from the bottom of the boat and discharging it at the stern." In these experiments Stevens was associated with Nicholas J. Roosevelt, Isambard Brunel, an exiled French royalist, and Chancellor Robert R. Livingston, Stevens' brother-in-law. It is said that in the same year, a boat was successfully tried on the Hudson, but details are not given.

Stevens' experiments in screw propulsion began in 1801, continuing until some time in 1806. Stevens believed himself to be the inventor of screw propulsion, but, as one of his descendants, Francis B. Stevens, writes, he was mistaken. It was proposed by the mathematician Bernouli in 1752, and was described by Bushnell in 1787 in a letter to Thomas Jefferson, describing a submarine boat to which was attached a screw propeller worked by hand.

The engines used in 1802, 1803 and 1804 were all non-condensing, the boilers being multitubular and generating steam at high pressure. The propeller was of the short 4-blade type now in common use. The engine and the results obtained with it are described in a letter from Stevens to the Medical and Philosophical Journal of New York, January 1812:

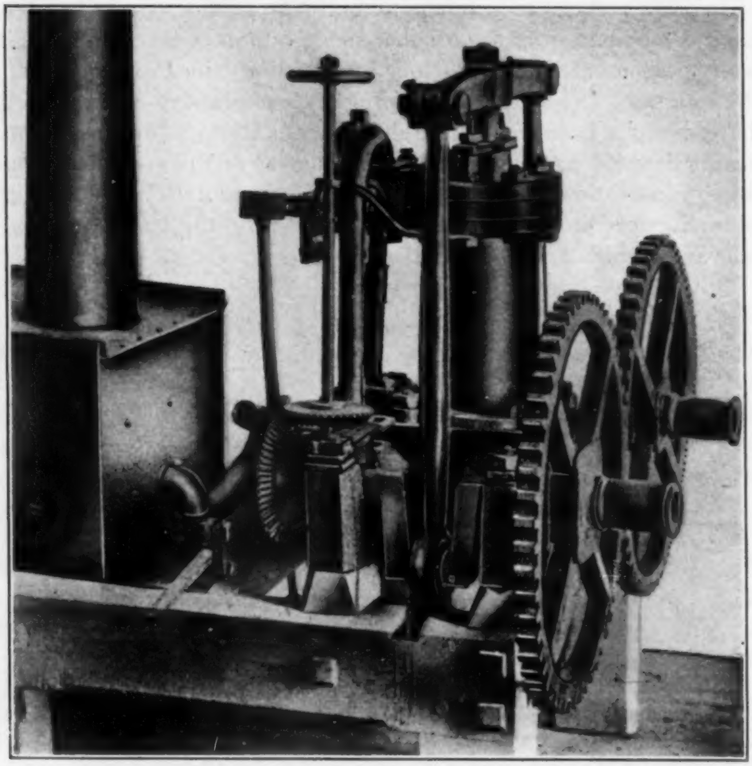
"A cylinder of brass, about 8 in. in diameter, and 4 in. long, was placed horizontally on the bottom of the boat; and by the alternate pressure of the steam on two sliding wings, an axis passing through its center was made to revolve. On one end of this axis, which passed through the stern of the boat, wings, like those on the arms of a windmill, were fixed, adjusted to the most advantageous angle for operating on the water.

"This constituted the whole of the machinery. Working with the elasticity of the steam merely, no condenser, no air pump was necessary; and as there were no valves, no apparatus was required for opening and shutting them. This simple little steam engine was, in the summer of 1802, placed on board a flat-bottomed boat I had built for the purpose. This boat was 25 ft. long, and about 5 or 6 ft. wide. She was occasionally kept going until the cold weather stopped us. When

the engine was in the best order, the velocity was about 4 miles an hour. I found it, however, impracticable, on so contracted a scale, to preserve due tightness in the packing of the wings in the cylinder for any length of time. This defect determined me to resort again to the reciprocating engine."

In the same letter he describes another experiment as follows:

"The unsuccessful experiment in which I had, as above stated, been engaged in conjunction with Chancellor Livingston and Mr. Roosevelt, had taught me the



ANOTHER VIEW OF COL. JOHN STEVENS' TWIN-SCREW ENGINE

indispensable necessity of guarding against the injurious effects of partial pressure. [By this term, he alluded to the imperfect bracing between the cylinder and shaft.] And accordingly I constructed an engine, although differing much from those described in the specifications of my patents, yet so modified, as to embrace completely the principle stated therein. During the winter, this small engine was set up in a shop I then occupied at the Manhattan Works, and con-

tinued occasionally in operation until spring, when it was placed on board the above mentioned boat, and by means of bevel cog wheels, it worked the axis and wings above mentioned and gave the boats somewhat more velocity than the rotary engine. But after having gone some time, in crossing the river, with my son on board, the boiler, which was constructed of small tubes inserted at each end into metal heads, gave way so as to be incapable of reparation."

To overcome the tendency of the boat with a single propeller to turn in a circle, it was fitted with two screws, revolving in opposite directions. One of the ends sought by Stevens was a high-speed engine connected directly to the propeller shaft. The reason for the abandonment of the plan of screw propulsion is explained, writes F. B. Stevens, by an inspection of the rude workmanship of the twin-screw engine, as well as that of the boiler.

"There were no tools or competent workmen in America at that date to properly construct the steam engines and the boilers that he planned between 1800 and 1806. Success was impossible.

"When he finally realized this, unwearied by his attempts to introduce steam navigation, dating from the year 1791, he reverted to the paddle wheel, with its slow-moving engine, and with the boilers then in use, carrying steam at the pressure of two or three pounds above the atmosphere. He was engaged in building the "Phoenix" when Fulton arrived from Europe with the engine made for him by Watt in 1806, which, complete in all its details, and in these respects, far in advance of any engine that could then have been built in this country, achieved success."

The subsequent career of the Phoenix has already been described in the October number of The Journal. To detail the other engineering achievements of John Stevens and his sons, Robert L. and Edwin A., would require many additional pages. A brief outline, therefore, will be given.

The multitubular boiler was patented by John Stevens in the United States in 1791 and 1803 and in England in 1805. A boiler with vertical iron tubes was operated on an experimental locomotive in 1825. It is said that he established the first steam ferry in the world, between New York and Hoboken on October 11, 1811. In 1813 John Stevens designed an iron clad vessel with a "saucer-shaped" hull, to be plated with iron and carry a heavy battery.

In 1812 (five years before the commencement of work on the Erie canal) John Stevens addressed a memoir to the New York State Commission urging the immediate construction of a railroad instead of a canal. Though Stevens' plans and estimates were definite and their accuracy was afterward proved, the commission reported adversely.

The South Carolina Railroad, which when completed in 1832 was the largest railway in the world, was constructed on the plans of 1812.

Through his efforts in 1823, the Legislature of Pennsylvania passed acts for incorporating the Pennsylvania Railroad Company "to make, erect and establish a railroad on the route laid out (from Philadelphia to Columbia, in Lancaster County) to be constructed on the plan and under the superintendence and direction of the said John Stevens."

Three years later, Colonel Stevens constructed at his own expense a locomotive with a multitubular boiler, which was operated for several years on a circular track at the Hoboken estate. This was the first locomotive in America driven by steam and running on a track, of which there is any record.

Colonel Stevens died in 1838, aged eighty-nine years. His son Robert L. appears to have surpassed his father in engineering ability. It was he who sailed the Phoenix on the first ocean trip made by a steam vessel. The Philadelphia, which he built, had a speed of 8 miles an hour. The North American, built in 1832, attained a speed of 15 miles. "For 25 years after 1815 he stood at the head of his profession." In 1821 he originated the form of ferry-boats and ferry slips now in general use.

The "cam board" cut-off was invented by Robert L. Stevens in 1818, and in 1821 he adopted the walking-beam and improved it by making it of wrought-iron strap with a cast-iron center.

His work in the railroad field includes the design, while president and chief engineer of the Camden & Amboy R. R., of the present form of rail; the "hook-headed" spike, substantially the present railroad spike; and the "iron-tongue," developed into the fish-plate.

Edwin A. Stevens appears to have followed the line of business more closely than engineering, though he also is credited with several engineering achievements. Space will not permit any description of his work other than to say that he was active in organizing and operating the Camden & Amboy R. R., in making with his brother Robert improvements in steam navigation, in introducing iron armor for warships, and in devising methods of attack and defence for ironclads. He died in 1868, in his will making provision for the endowment of Stevens Institute of Technology, in Hoboken.

NECROLOGY

LEWIS CLESSON GROVER

Lewis Clesson Grover died at Hartford, Conn., September 30, 1909, after a long illness. He was born November 26, 1849, at Springfield, Mass. After an ordinary school education there, he acted as apprentice at the Norwalk Iron Works, Norwalk, Conn., for three years; after seven years' service with this company, serving for short periods with the Winchester Repeating Arms Co., New Haven, Conn., C. W. Lacount of Norwalk, Conn., Smith & Wesson, Springfield, Mass., and F. C. & A. E. Rowland, New Haven, Conn.

He became general manager of the Whitney Arms Company, New Haven, Conn., about 1880, holding this position until 1886, when he went to Hartford as assistant superintendent of the Colt's Patent Fire Arms Mfg. Co. He was soon promoted to the office of superintendent, and later to that of general manager. In 1902 he was elected president and a director of the company, at the same time becoming president of the Colt's Arms Co., of New York. Because of ill health he was finally compelled to relinquish to others the active duties of management, and in January resigned the office of president, the same meeting making him chairman of the boards of directors of both corporations.

Mr. Grover served as a member of the common council board of Hartford and as park commissioner. He was a prominent Mason and a member of the Hatchetts Reef Club. He entered this Society in 1890.

ROBERT HOE

Robert Hoe, head of the firm of Robert Hoe & Co., of New York and London, was born in New York, March 10, 1839, and was educated in public and private schools in this city. He was grandson of Robert Hoe of the hamlet of Hoes, Leicestershire, England, who began the manufacture of printing machines in New York in 1803, constructing and introducing into America the first iron and steel machines.

Mr. Hoe at an early age entered the printing factory established by his grandfather, and devoted his life to the improvement and develop-

ment of printing machinery. He developed the rotating-cylinder type of press to the present double-octuple press capable of printing, pasting, folding and delivering more than 150,000 16-page newspapers per hour. He also invented greatly improved processes of printing in colors, and is the author of several books on printing and binding.

Mr. Hoe always resided in New York, though his business interests were almost as great in London, and identified himself with its interests and prosperity. He was one of the founders of the Metropolitan Museum of Arts, founder and first president of the Grolier Club, and a member of the Engineers', Union League, Century, Players' and Fencers' Clubs. He joined The American Society of Mechanical Engineers in 1883.

Mr. Hoe died in London, September 22, 1909.

ROBERT B. LINCOLN

Robert B. Lincoln, president of the Waters Governor Company, Boston, Mass., died June 9, 1909, at his home in Waltham, Mass. Mr. Lincoln began his career in the Globe Works in Boston, afterwards serving throughout the Civil War. In 1868 he went to Cuba as chief engineer of the Maratanza, severing this relationship to become head draftsman at the South Boston Iron Works. In 1882 he designed the compound engine on the Cymbria at East Boston, Mass., and was subsequently connected with E. D. Leavitt of Cambridge, Mass., and later with the Portsmouth Navy Yard, where he remained nine years. At the time of his death, he had been president of the Waters Governor Company, for twenty-seven years, and during his life had held many other positions of trust which were filled with honor and fidelity.

PERSONALS OF THE MEMBERSHIP AM.SOC.M.E.

Arthur S. Blanchard, formerly with the Atha Steel Casting Co., Newark, N. J., is now associated with the Birdsboro Steel Foundry and Machine Co., Birdsboro. Pa., in the capacity of assistant general manager.

Dr. John A. Brashear addressed the October 19 meeting of the Engineers' Society of Western Pennsylvania, which was devoted to a discussion of Rapid Transit for Pittsburg.

Thurlow E. Coon has been appointed manager of the Detroit, Mich., office of the Ball Engine Co., and will at the same time handle a complete line of power plant equipment.

Claude E. Cox has accepted a position with the H. E. Wilcox Car Co., Minneapolis, Minn. Mr. Cox was until recently chief engineer and factory manager of the Interstate Automobile Co., Muncie, Ind.

R. G. Davis served as acting-quartermaster on the Clermont II during the Hudson-Fulton Celebration.

An article on Correct Metal for Castings, by Almon Emrie, was published in the October 7 issue of *The American Machinist*.

W. S. Giele, until recently superintendent of the plant of the Stoever Foundry and Mfg. Co., Myerstown, Pa., has severed his connection with that company. Mr. Giele is devoting his time to special work, and is living at New Brighton, S. I.

Warren W. Gore, formerly vice-president of the Gas Power Mfg. Co., Seattle, Wash., is now in charge of the experimental department of the Fairbanks-Morse factory in Beloit, Wis.

Chas. H. Green, member of the firm of M. A. Earl & Co., is now located at the Carthage, Mo., office of the company. He was formerly at the Muskogee, Okla., office.

An article on Production and Waste of Mineral Resources by Dr. J. A. Holmes, was published in the October 2 number of *The Mining World*.

Alfred Noble has been appointed consulting engineer to the Board of Water Supply, New York.

Harold L. Pope has become associated with the Matheson Motor Car Co., Wilkes-Barre, Pa., as engineer. He was formerly general manager of the Toledo Motor Co., Toledo, O.

Prof. Walter Rautenstrauch has contributed an article on An Investigation of Strength of Crane Hooks, to the October 7 issue of *The American Machinist.*

J. G. Clifton Sewell has become identified with the United Engine and Foundry Company, Pittsburg, Pa. Mr. Sewell was formerly associated with the Tennessee Coal, Iron and Railroad Co., Pittsburg, Pa.

G. B. Shipley contributed an article on A Comparison of the Various Processes of Preserving Timber, to the October 14 number of *Engineering News.*

Edward S. Smith has been appointed instructor in mathematics at the University of Virginia, University, Va. Until recently he was instructor in mechanical drawing in the School of Mines and Metallurgy of the University of Missouri, Rolla, Mo.

J. F. Taddiken, Jr., has been transferred from the Chino, Cal., branch of the American Beet Sugar Co., to the Rocky Ford, Colo., branch.

Dr. C. J. H. Woodbury is the author of a Bibliography of Cotton Manufacture, recently published.

THE JOURNAL

OF

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

VOL. 31 MID-NOVEMBER 1909 NUMBER 11

THE ANNUAL MEETING

The thirtieth annual meeting of the Society will be held in the Engineering Societies Building, 29 West 39th St., New York, December 7 to 10.

The Meetings Committee, Mr. Willis E. Hall, Chairman, having entire charge of the professional program and the arrangement of professional sessions, has provided a list of strong papers upon varied subjects; a preliminary program, subject to revision, being published in the following pages.

For the first time at an annual convention of the Society the entire social entertainment will be in charge of the members resident in and about New York, under the immediate direction of a local committee appointed by them, of which Mr. William D. Hoxie is chairman. For Wednesday afternoon of the convention an excursion is planned which the members and guests will be asked to attend in a body, and during the balance of the time there will be opportunities for smaller parties to visit places of interest. Full announcement of the entertainment features, which form so important a part of these meetings, will be made in the next number of The Journal.

It is not possible for the Secretary to undertake to reserve hotel accommodations for visiting members. They are recommended to communicate directly with the hotel at which they wish to stop.

PRELIMINARY PROGRAM FOR THE ANNUAL MEETING[1]

OPENING SESSION

Tuesday, December 7, 8.15 p.m., Main Auditorium

The President's Address
Report of tellers of election of officers
Introduction of new president

The reading of the President's address will be followed by a social gathering at which ladies will be especially welcome.

BUSINESS MEETING

Wednesday, December 8, 9.30 a.m. Main Auditorium

Annual business meeting. Reports of the Council, tellers of election of membership, standing and special committees and Gas Power Section. Amendments to the Constitution. New business may be presented at this session.

Luncheon will be served to members and guests at 1. p.m. on the fifth floor of the building. The afternoon of this day will be left free for members and guests to go on an excursion planned by the Excursion Committee.

PROFESSIONAL SESSION

Wednesday, 8.15 p.m., Main Auditorium

(To be assigned)

PROFESSIONAL SESSIONS

Thursday, December 9, 9.30 a.m. Main Auditorium

MEASUREMENT OF THE FLOW OF FLUIDS

TESTS ON A VENTURI METER FOR BOILER FEED by Chas. M. Allen
THE PITOT TUBE AS A STEAM METER, Geo. F. Gebhardt

[1] Subject to Revision.

All professional meetings of the Society will be called to order at the time specified on the program.

EFFICIENCY TESTS OF STEAM NOZZLES, F. H. Sibley and T. S. Kemble

AN ELECTRIC GAS METER, C. C. Thomas

Luncheon will be served to members and guests on the fifth floor of the building at 1 p.m.

Thursday, 2 p.m., Main Auditorium

STEAM ENGINEERING

TAN BARK AS A BOILER FUEL, David M. Myers

COOLING TOWERS FOR STEAM AND GAS POWER PLANTS, J. R. Bibbins

SOME STUDIES IN ROLLING MILL ENGINES, W. P. Caine

AN EXPERIENCE WITH LEAKY VERTICAL FIRE TUBE BOILERS, F. W. Dean

THE BEST FORM OF LONGITUDINAL JOINT FOR BOILERS, F. W. Dean

Thursday, 2 p.m., Auditorium, 6th floor

SIMULTANEOUS SESSION

GAS POWER SECTION

Business meeting and election of officers.

TESTING SUCTION GAS PRODUCERS WITH A KOERTING EJECTOR, C. M. Garland, A. P. Kratz

(Subjects of other papers to be announced)

RECEPTION

Thursday, 9 p.m.

This will be the social event of the meeting in which members and guests and especially the ladies are invited to participate. Cards of admission will be required, which can be obtained from the Local Committee at the registration desk.

PROFESSIONAL SESSION

Friday, December 10, 9.30 a.m., 6th floor

THE BUCYRUS LOCOMOTIVE PILE DRIVER, Walter Ferris

LINE-SHAFT EFFICIENCY, MECHANICAL AND ECONOMIC, Henry Hess

PUMP VALVES AND VALVE AREAS, A. F. Nagle

A REPORT ON CAST-IRON TEST BARS, A. F. Nagle

RAILROAD TRANSPORTATION NOTICE

For members and guests attending the Annual Meeting in New York, December 7-10, 1909, the special rate of a fare and three-fifths for the round trip, on the certificate plan, is granted when the regular fare is 75 cents and upwards, from territory specified below.

a Buy your ticket at full fare for the going journey, between December 3 and 9 inclusive, and get a certificate, *not a receipt*, securing these at least half an hour before the departure of the train.

b Certificates are not kept at all stations. If your station agent has not certificates and through tickets, he will tell you the nearest station where they can be obtained. Buy a local ticket to that point and there get your certificate and through ticket.

c On arrival, present your certificate to S. Edgar Whitaker at headquarters, with 25 cents for validation. A certificate cannot be validated after December 10.

d An agent of the Trunk Line Association will validate certificates December 8, 9 and 10. No refund will be made on account of failure to have certificate validated.

e One hundred certificates must be presented for validation before the plan is operative. This makes it important to ask for certificate, and to turn it in at headquarters. Even though you may not use it this will help others to secure the reduced rate.

f If certificate is validated, a return ticket to destination can be purchased, up to December 14, on the same route over which the purchaser came, at three-fifths the rate.

This special rate is granted only for the following:

Trunk Line Association:

All of New York east of a line running from Buffalo to Salamanca, all of Pennsylvania east of the Ohio River, all of New Jersey, Delaware and Maryland; also that portion of West Virginia and Virginia north of a line running through Huntington, Charleston, White Sulphur Springs, Charlotteville, and Washington, D. C.

Central Passenger Association:

The portion of Illinois south of a line from Chicago through Peoria to Keokuk and east of the Mississippi River, the States of Indiana, and Ohio, the portion of Pennsylvania and New York north and west of the Ohio River, Salamanca and Buffalo, and that portion of Michigan between Lakes Michigan and Huron.

New England Passenger Association, except via Bangor and Aroostook R. R., Rutland R. R., N. Y. O. & W. R. R., Eastern Steamship Co. and Metropolitan Steamship Co.

Maine, New Hampshire, Vermont, Massachusetts, Rhode Island and Connecticut.

The Western Passenger Association offer revised one-way fares to Chicago, Peoria and St. Louis; these three places are points in the Central Passenger Association, and from these points purchase round trip tickets, in the manner outlined in the preceding paragraphs:

North Dakota, South Dakota, Nebraska, Kansas, Colorado, east of a north and south line through Denver, Iowa, Minnesota, Wisconsin, Missouri; north of a line through Kansas, Jefferson City and St. Louis, Illinois; north of a line from Chicago through Peoria to Keokuk.

Eastern Canadian Passenger Association:

Canadian territory east of and including Port Arthur, Sault Ste. Marie, Sarnia and Windsor, Ont.

IMPROVEMENTS IN THE ROOMS OF THE SOCIETY

The headquarters of the Society have recently been made more attractive than ever before by appropriate additions to the furnishings and by rearrangement of the rooms. When the Society entered the new headquarters nearly three years ago, provisional furnishings were purchased comprising only what was essential to carrying on the business of the Society with no attempt at decorative features. The members will be pleased to find the rooms as homelike as can be desired and convenient in every way as a rendezvous for the members and their friends.

During the past year the Council authorized these improvements and the work is being carried out under the direction of the House Committee, consisting of Henry S. Loud, *Chairman*, W. C. Dickerman, Bernard V. Swenson, Francis Blossom and Edward Van Winkle. The original plans of the rooms provided for a large reception hall, with an attractive alcove, which visitors enter from the elevators. In common with the other floors of the building this hall was open to the stairway connecting the several floors. A partition cutting off this stairway and another partition separating the offices at the rear, has converted this hall into a reception room which is not only pleasing in appearance but thoroughly comfortable.

Wide sliding doors connect the three main rooms, known as the Council Room, the Library and the Secretary's office, which, usually remaining open, give the effect of one spacious room.

The floors of the Reception Room, the Council Room and the Library have been covered with handsome rugs and the walls tinted in harmony with them. Comfortable upholstered furniture has been placed in the Reception Room and cushions on the seats in the alcove. Improvements now being carried out will include portieres between the rooms, draperies at the windows and comfortable divans and chairs in the Council Room and Library, and shelves in the Library for books which will furnish a pleasant half hour while waiting for a friend.

In undertaking this work the House Committee has endeavored so to complete the furnishing as to make the already beautiful rooms of the Society so homelike as to form a constant reminder to the mem-

bership of the pleasant rooms at the former home of the Society at 12 West 31st Street, and to make a place which members will use freely for their own convenience, and in meeting other members or friends for social or business engagements. In addition to the three large rooms referred to a small room is especially reserved for members of the Society, where they may have quiet to attend to their correspondence or to hold conferences in private.

Fine art photographs of the past-presidents have been placed on the walls of the Library and by order of the Council a similar photograph of each succeeding president will be added as he retires from office.

An improvement which will be greatly appreciated by the membership is the placing of a name-plate on each of the portraits, paintings and other historical objects in the rooms of the Society. A very complete catalogue of all of these objects of historical interest has been carefully prepared after long and painstaking research by Edward Van Winkle of the House Committee. The members will find much of interest in this work which will be open to them in the Library.

It is hoped that all members of the Society when they are in New York will make a special effort to come to the rooms and make use of the comforts and conveniences which have been provided for them.

GENERAL NOTES

BROOKLYN POLYTECHNIC STUDENT SECTION, AM.SOC.M.E.

At the annual meeting of the Brooklyn Polytechnic Student Section affiliated with The American Society of Mechanical Engineers, held October 16, Chairman J. M. Russell, presiding, the following officers were elected: John S. Kerins, chairman; Russell C. Brown, vice-chairman; Percy Gianella, secretary; Wilbur N. Sar Vant, treasurer. The committee on admissions reported a membership of 107. The address of the evening was on Industrial Engineering, its Province, Limitations, Ideals, by Charles Buxton Going.

PURDUE MECHANICAL ENGINEERING SOCIETY

Meetings of Purdue Mechanical Engineering Society, of Purdue University, Lafayette, Ind., affiliated with The American Society of Mechanical Engineers, were held upon October 6 and 20, with addresses by Prof. J. D. Hoffman, on The Manufacture of Paper from Wood Pulp; and Mr. Fenstermaker of the American Engineering Supply Co. of Indianapolis, on The Application of the Vacuum System of Heating to Old Factory Plants.

AMERICAN STREET RAILWAY ASSOCIATION

The annual meeting of the American Street Railway Association took place this year at Denver, Colo., October 4 to 8. Excursion trains were run from points East and West, and the attendance was over 2500 members and guests. The sessions were held in a large auditorium built for the purpose, with rooms for the various sectional meetings and for an exhibit of machinery, equipment and supplies. The convention was opened after an address of welcome by Wm. G. Evans, president of the Denver City Tramway Company, by the presidential address of James F. Shaw, which rehearsed street railway conditions for the year. Organization from the Standpoint of Smaller Companies was the title of an important paper by Ernest Gonzenbach, president of the Cheboygan Company. With the exception of the secretary, Bernard V. Swenson, Mem.Am.Soc.M.E., resigned, the

retiring officers were re-elected. A secretary will be appointed by the president.

The auxiliary organizations of the association, which held executive sessions simultaneously with the parent society, were the Traffic and Transportation Association, the Accountants' Association, the Claim Agents' Association, and the American Street and Interurban Railway Engineering Association. At the sessions of the latter, the annual address was made by Paul Winsor. Officers of the American Street and Interurban Railway Engineering Association were elected as follows: president, F. H. Lincoln, Philadelphia, Pa., vice-presidents, W. J. Harvie, Syracuse, N. Y., E. O. Ackerman, Columbus, O., J. S. Doyle, New York, J. W. Corning, Boston, Mass.

AMERICAN ASSOCIATION OF RAILROAD SUPERINTENDENTS

The Central Association of Railroad Officers at their twenty-second annual meeting, held at Cincinnati, O., September 22 and 23, adopted a new constitution, which it is felt will broaden the scope of the organization. The name is changed to the American Association of Railroad Superintendents. The organization now has divisions at the following points: Cincinnati, O.; Indianapolis, Ind.; Columbus, O.; Toledo, O.; Peoria, Ill.; St. Louis, Mo.; Kansas City, Mo.; Louisville, Ky.; Detroit, Mich.; Denver, Colo.; Omaha, Neb.; Memphis, Tenn.

The following officers were elected: president, J. A. Somerville; vice-presidents, Brent Arnold, S. M. Russell; secretary-treasurer, O. G. Fetter.

NATIONAL MACHINE TOOL BUILDERS' ASSOCIATION

The eighth annual convention of the National Machine Tool Builders' Association was held in New York October 12 and 13, with headquarters at the Hotel Astor. The attendance at the opening session was larger than ever before. The annual presidential address was made at this session by Fred. L. Eberhardt, of Newark, N. J., Mem.Am.Soc.M.E. There was discussion on The Standardization of Electric Motors used in Connection with Machine Tool Drive; and on The Creation of Machinists, introduced by a paper. Papers on Industrial Education were also submitted by Frederick A. Geier, of the Cincinnati Milling Machine Company, Mem.Am.Soc.M.E., and M. A. Coolidge, who dealt with the Fitchburg plan. A lecture entitled The Perils of Peace, or A Safer America, was delivered by J. P. H. Perry, of New York.

The election of officers resulted as follows: president, F. A. Geier, Mem.Am.Soc.M.E.; vice-presidents, F. L. Eberhardt, Mem.Am.Soc. M.E., the retiring president, P. E. Montanus, Springfield, O., the retiring secretary; secretary, C. Hildreth, Worcester, Mass.; treasurer, G. W. Fifield, Lowell, Mass. The Spring meeting of the association will be held at Rochester, N. Y.

Many members of the association were entertained at a theater party given by *The American Machinist;* and on the annual outing of *Machinery*, to Fort Hancock and the Sandy Hook Proving Grounds.

RAILWAY SIGNAL ASSOCIATION

The annual meeting of the Railway Signal Association was held at the Seelbach Hotel, Louisville, Ky., October 12 to 14. President L. R. Clausen in his opening address spoke of the vigorous growth of the association since its formation in Chicago in 1895, from 6 members to more than 1100. The discussion was on Signaling Practice. The election of officers, by letter-ballot, was announced: president, H. S. Balliet, of New York; vice-president, C. C. Anthony, of Philadelphia, Pa.; secretary, C. C. Rosenberg, Bethlehem, Pa.; Eastern and Western representatives on the executive committee, C. J. Kelloway and B. H. Mann, respectively.

AMERICAN SOCIETY OF REFRIGERATING ENGINEERS

At the Chicago meeting of the American Society of Refrigerating Engineers, October 18 and 19, papers were presented by J. C. Wm. Greth, Mem.Am.Soc. M.E., on Water Purification for Ice and Refrigerating Plants; Walter L. Hill, Assoc.Am.Soc.M.E., on Cold Storage Temperatures; Dr. Charles E. Lucke, Mem.Am.Soc.M.E., on Wet vs. Dry Compression; Fred. W. Wolf, Jr., Mem.Am.Soc.M.E., on Autogenous Welding. There will be a meeting in New York December 6.

ILLUMINATING ENGINEERING SOCIETY OF GREAT BRITAIN

The first of the technical sessions of the Illuminating Engineering Society recently organized in London will be held in November. The honorary secretary of the society is Leon Gaster, editor of *The Illuminating Engineer*, of London, and Prof. S. P. Thompson has consented to become the first president. Influential support has been received from many distinguished authorities on matters of illumination in Great Britain, on the Continent and in America, and a representative council has been formed.

PERSONALS OF THE MEMBERSHIP AM. SOC. M.E.

Robert W. Angus gave an address at the October 14 meeting of the Engineers' Club of Toronto, in which he described some of the better European science laboratories and large factories.

Chas. Edgar Ard has assumed the duties of manager of Christopher, Ard & Co., Starkville, Miss. He was formerly professor of physics and electrical engineering, Mississippi Agricultural and Mechanical College, Agricultural College, Miss.

Earle J. Banta has become identified with the Cincinnati Equipment Company, Cincinnati, O. Mr. Banta was until recently mechanical engineer, Isthmian Canal Commission, Culebera, Canal Zone, C. A.

John H. Barr, second vice-president and factory manager of the Smith Premier Works, has been promoted to the position of consulting engineer with the Union Typewriter Company, with headquarters in New York. While Mr. Barr will be connected with the general company he will still be associated with the Smith Premier Company of Syracuse.

Joseph G. Branch has been appointed president of The Branch Publishing Company, Chicago, Ill.

Edward W. Burgess has become identified with the Metzger Motor Car Company, Detroit, Mich. He was until recently mechanical engineer of the Whitlock Coil Pipe Company, Hartford, Conn.

Henry M. Byllesby has been elected president of the Civic Federation of Chicago, and chairman of its executive committee.

Theodore N. Case, recently chief engineer of the Kerr-Murray Mfg. Co., Fort Wayne, Ind., expects to purchase and to operate an irrigated farm in the Klamath project of the U. S. Reclamation Service, and incidentally to manufacture and install acetylene gas apparatus in that vicinity.

William L. Cathcart has contributed an article on Heat Losses from Steam Pipes to the November issue of *Cassier's Magazine*.

George E. Chamberlain of La Grange, Ill., has accepted the presidency of the Lewell Mfg. Co., Chicago, Ill.

Eugene Childs, formerly connected with the Trimont Mfg. Co., Roxbury, Mass., has been made president and general manager of the Springfield Drop Forge Co., Springfield, Mass., recently acquired by the Lakeside Forge and Wrench Co., Springfield, Mass.

Peter Eyermann has resigned his position with the Du Bois Iron Works, Du Bois, Pa., as chief engineer, and accepted an engagement with the Austrian steel works at Witkowitz, Austria.

Aime L. G. Fritz, until recently associated with Ford, Bacon & Davis, New York, has entered the service of the Tee Square & Triangle Co., Newark, N. J.

Chester B. Hamilton, Jr., has accepted a position with Smith, Kerry & Chace, Toronto, Ont.

Clarence H. Helvey has become connected with the Republic Motor Car Company, Hamilton, O. He was formerly with the Hamilton Engineering Company, Hamilton, O.

Walter G. Holmes, formerly with the American Sterilizer Co., Erie, Pa., has been made chief draftsman of the Linderman Machine Co., Muskegon, Mich.

Chas. M. Jarvis, vice-president of the American Hardware Corporation, New Britain, Conn., has been elected a director of the Colt's Patent Fire Arms Mfg. Co., Hartford, Conn.

James McNaughton has been elected a director of the Colorado Fuel & Iron Co.

R. S. deMitkiewicz, formerly with the Fairbanks Company, in gas power work, has become connected with the New York office of the Alden, Sampson Mfg. Co., of Pittsfield, Mass.

John N. Mowery, mechanical engineer of the Lehigh Valley Railroad, South Bethlehem, Pa., has been transferred to Auburn, N. Y., in the capacity of assistant master mechanic.

George A. Orrok delivered a lecture on The Gas Engine in Relation to Blast Furnace Practice, before the November 10 meeting of the Society of Engineers of Eastern New York.

R. B. Owens, formerly professor of electrical engineering, McGill University, Montreal, P. Q., has become associated with the Southern Power Company, Charlotte, N. C.

T. Elliott Payson, consulting engineer, Jersey City, N. J., has accepted a position as superintendent of works with the Edengraph Mfg. Co., New York.

Chas. C. Phelps, formerly associated with the Gage Publishing Co., New York, has been appointed editor of *Steam*, New York.

Auguste L. Saltzman, consulting engineer, East Orange, N. J., has accepted a position with Walter Scott & Co., in charge of the drafting department.

Richard A. Smart has assumed the position of works manager of the Oliver Chilled Plow Works, South Bend, Ind. He was formerly assistant manager of works of the Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

William H. Smead has accepted a position with the General Fire Extinguisher Company, Warren, O. Mr. Smead was formerly associated with the Proximity Mfg. Co.'s Mills, Greensboro, N. C.

John Sturgess, formerly general manager of the Lombard & Replogal Governor Co., Akron, O., has become associated with the Platt Iron Works Company, Dayton, O., as Western representative.

E. H. Symington, formerly manager Western sales of the T. H. Symington Co., Chicago, Ill., is now located at the Rochester, N. Y., plant as works sales manager of the company.

Godfrey M. S. Tait will present a paper on Gas Power Plants at the November 16 meeting of the Modern Science Club, Brooklyn, N. Y.

Max E. R. Toltz, formerly located at the Chicago, Ill., office of the Manistee & Grand Rapids R. R., is now with the St. Paul, Minn., office. Mr. Toltz is general manager of the company.

Charles Waterman, formerly with the Maxwell Briscoe Motor Co., New Castle, Ind., has been appointed superintendent of the Southern Motor Works, Jackson, Tenn.

H. C. Whitehurst, with the firm of Evans, Almirall & Co., New York, has been placed in charge of that company's new branch office at Richmond, Va.

G. A. Young, assistant professor mechanical engineering, Purdue University, has taken a leave of absence and will spend a year in the Graduate School of Harvard University. Professor Young is taking some special work in the line of research in thermodynamics.

THE JOURNAL

OF

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

VOL. 31 DECEMBER 1909 NUMBER 12

THE ANNUAL MEETING

The Thirtieth Annual Meeting of the Society will be held in the Engineering Societies' Building, 29 West 39th Street, New York, December 7 to 10.

The Meetings Committee, Willis E. Hall, *Chairman*, having entire charge of the professional program has arranged for four professional sessions at which papers are to be presented. On Wednesday morning following the regular business meeting important reports of the Gas Power Section will be presented for discussion. The sessions comprise a symposium on the Measurement of the Flow of Fluids with papers taking up the measurement of feed water, steam, air and gas. One session will be devoted to Steam Engineering subjects and another will be in charge of the Gas Power Section. For the latter session two papers of much interest have been assigned and additional reports not given at the time of the business meeting of the Society will be brought up for discussion.

ENTERTAINMENT

For the first time at an annual convention of the Society the social entertainment will be in charge of the members resident in and about New York under the immediate direction of a Local Committee appointed by them of which William D. Hoxie is Chairman. For Wednesday afternoon an excursion is planned which the members and guests will be asked to attend in a body and during the balance of the time there will be opportunities for smaller parties to visit places of interest.

Special efforts will be made to extend hospitality to out-of-town members and ladies and to promote an atmosphere of sociability which will facilitate the forming of friendships, the most important opportunity of the convention.

A Ladies' Reception Committee will arrange for the entertainment of the ladies in a manner similar to that of last year.

RECEPTIONS AND EVENING MEETINGS

At the opening session on Tuesday evening will be the introduction of the new President and the reading of the President's address, followed by a social gathering. On Wednesday evening there will be a lecture of unusual interest upon the Development of Agricultural Machinery by L. W. Ellis of the Bureau of Plant Industry of the Agricultural Department, Washington, D. C. He has at his disposal the information and photographs for slides that have been acquired by the Agricultural Department, showing the wonderful resources of the country on the great farms of the West, and he will dwell very largely on the development of the machinery which has kept pace with it and in which all engineers are interested.

On Thursday evening will be the reception, which will be held in the grand ballroom of the Hotel Astor. Boxes in the balcony will be available for members and guests who wish to attend and not participate in the dancing.

HEADQUARTERS

The headquarters will be established in the foyer on the first floor of the Engineering Societies' Building. Members and guests are requested to register immediately upon their arrival and receive a badge and program. Railroad certificates should be presented at that time for validation. A writing room will be provided on the first floor opposite the entrance fully equipped for the use of members. There is also a telephone exchange with several booths on the first floor adjoining the elevators, providing ample facilities for quick service.

MEMBERS REGISTER

Two editions of the printed Members Register will be issued. The first will include the names of those registered before 9 p.m. Tuesday, and will be distributed at the morning session on Wednesday. The second edition will contain the names of those registered before 10 p.m. on Wednesday. It will be distributed at the morning session on Thursday.

PROGRAM[1]

NEW YORK, DECEMBER 7–10, 1909

OPENING SESSION

Tuesday, December 7, 8.30 p.m., Auditorium

The President's Address.

Report of tellers of election of officers.

Introduction of the President-elect.

Reception by the President and President-elect, with their ladies, to the Membership of the Society, their ladies and friends, in the rooms of the Society. All are invited.

Music and refreshments.

Col. E. D. Meier, Chairman Sub-Committee in charge of President's Reception.

BUSINESS MEETING

Wednesday, December 8, 9.30 a.m., Auditorium

Annual business meeting. Reports of the Council, tellers of election of membership, standing and special committees and Gas Power Section. Amendments to the Constitution. New business may be presented at this session.

A luncheon will be served to the Membership and guests, on the fifth floor of the building, at 1.00 p.m. Cards may be obtained at the registration desk from the Sub-Committee in charge.

Wednesday afternoon

Excursion to points of engineering interest. Mr. Hosea Webster Chairman Sub-Committee on Excursions.

LECTURE

Wednesday, 8.15 p.m., Auditorium

Lecture by Mr. L. W. Ellis on the Development of Agricultural Machinery. Illustrated with lantern views.

PROFESSIONAL SESSIONS

Thursday, December 9, 9.30 a.m., Auditorium

MEASUREMENT OF THE FLOW OF FLUIDS

TESTS ON A VENTURI METER FOR BOILER FEED, by Chas. M. Allen.

THE PITOT TUBE AS A STEAM METER, Geo. F. Gebhardt.

[1] Subject to revision

All professional meetings of the Society will be called to order at the time specified on the program.

Efficiency Tests of Steam Nozzles, F. H. Sibley and T. S. Kemble

An Electric Gas Meter, C. C. Thomas.

A luncheon will be served to the Membership and guests, on the fifth floor at 1.00 p.m. Cards may be obtained at the registration desk from the Sub-Committee in charge.

Thursday, 2 p.m., Auditorium

STEAM ENGINEERING

Tan Bark as a Boiler Fuel, David M. Myers.

Cooling Towers for Steam and Gas Power Plants, J. R. Bibbins.

Some Studies in Rolling Mill Engines, W. P. Caine.

An Experience with Leaky Vertical Fire Tube Boilers, F. W. Dean.

The Best Form of Longitudinal Joint for Boilers, F. W. Dean.

Thursday, 2 p.m., Lecture Hall, 6th floor

GAS POWER SECTION

Business meeting and election of officers

Testing Suction Gas Producers with a Koerting Ejector C. M. Garland, A. P. Kratz.

Bituminous Producers, J. R. Bibbins.

RECEPTION

Thursday, 9 p.m., Hotel Astor

Reception by the Members of New York and vicinity to the Officers and Membership of the Society, their ladies and guests, at the Hotel Astor.

Dancing and refreshments.

Cards will be required, obtainable at the Registration desk, from the Sub-Committee in charge.

Prof. Arthur L. Williston, Chairman Sub-Committee in charge of the Reception.

PROFESSIONAL SESSION

Friday, December 10, 9.30 a.m., 6th floor

The Bucyrus Locomotive Pile Driver, Walter Ferris.

Line Shaft Efficiency, Mechanical and Economic, Henry Hess.

Pump Valves and Valves Areas, A. F. Nagle.

A Report on Cast-Iron Test Bars, A. F. Nagle.

RAILROAD TRANSPORTATION NOTICE

For members and guests attending the Annual Meeting in New York, December 7-10, 1909, the special rate of a fare and three-fifths for the round trip, on the certificate plan, is granted when the regular fare is 75 cents and upwards, from territory specified below.

a Buy your ticket at full fare for the going journey, between December 3 and 9 inclusive, and get a certificate, *not a receipt*, securing these at least half an hour before the departure of the train.

b Certificates are not kept at all stations. If your station agent has no certificates and through tickets, he will tell you the nearest station where they can be obtained. Buy a local ticket to that point and there get your certificate and through ticket.

c On arrival, present your certificate to S. Edgar Whitaker at headquarters, with 25 cents for validation. A certificate cannot be validated after December 10.

d An agent of the Trunk Line Association will validate certificates December 8, 9 and 10. No refund will be made on account of failure to have certificate validated.

e One hundred certificates must be presented for validation before the plan is operative. This makes it important to ask for a certificate, and to turn it in at headquarters. Even though you may not use it this will help others to secure the reduced rate.

f If the certificate is validated, a return ticket to the destination can be purchased, up to December 14, on the same route over which the purchaser came, at three-fifths the rate.

This special rate is granted only for the following:

Trunk Line Association:

All of New York east of a line running from Buffalo to Salamanca, all of Pennsylvania east of the Ohio River, all of New Jersey, Delaware and Maryland; also that portion of West Virginia and Virginia north of a line running through Huntington, Charleston, White Sulphur Springs, Charlotteville, and Washington, D. C.

Central Passenger Association:

The portion of Illinois south of a line from Chicago through Peoria to Keokuk and east of the Mississippi River, the States of Indiana, and Ohio, the portion of Pennsylvania and New York north and west of the Ohio River, Salamanca and Buffalo, and that portion of Michigan between Lakes Michigan and Huron.

New England Passenger Association, except via Bangor and Aroostook R. R., Rutland R. R., N. Y. O. & W. R. R., Eastern Steamship Co. and Metropolitan Steamship Co.

Maine, New Hampshire, Vermont, Massachusetts, Rhode Island and Connecticut.

The Western Passenger Association offer revised one-way fares to Chicago, Peoria and St. Louis; these three places are points in the Central Passenger Association, and from these points purchase round trip tickets, in the manner outlined in the preceding paragraphs:

North Dakota, South Dakota, Nebraska, Kansas, Colorado, east of a north and south line through Denver; Iowa, Minnesota and Wisconsin. Missouri north of a line through Kansas, Jefferson City and St. Louis; Illinois north of a line from Chicago through Peoria to Keokuk.

Eastern Canadian Passenger Association:

Canadian territory east of and including Port Arthur, Sault Ste. Marie, Sarnia and Windsor, Ont.

OTHER COMING MEETINGS OF THE SOCIETY

At the meeting of the Society to be held in Boston on December 17, at the Edison Auditorium, the following papers will be presented, forming a symposium on the Effect of Superheated Steam on Cast Iron and Steel:

Cast-Iron Fittings for Superheated Steam, by Prof. I. N. Hollis.

The Effect of Superheated Steam on the Strength of Cast Iron, Gun Iron, and Steel, by Prof. E. F. Miller.

Cast-Iron Valves and Fittings for Superheated Steam, by Arthur S. Mann.

A meeting of the Society will be held at St. Louis, December 11.

RECENT MEETINGS OF THE SOCIETY

BOSTON, OCTOBER 20

On Wednesday evening, October 20, a meeting of the Society was held at Boston with the Boston Society of Civil Engineers, in Tremont Temple. A paper on the Strength of Reinforced Concrete Beams was presented by Prof. Gaetano Lanza, followed by an interesting discussion in which the following took part; Vice-President Chas. T. Main, of the Boston Society of Civil Engineers, F. Sumner Hinds Desmond FitzGerald, Robert L. Read, Prof. C. M. Spofford, Henry F. Bryant, Prof. Geo. F. Swain, Rolf R. Newman. Contributed discussion was also presented by J. R. Worcester and Harry E. Sawtelle.

NEW YORK, NOVEMBER 9

At the meeting of the Society at New York on November 9, Professor Lanza presented his paper on Stresses in Reinforced Concrete Beams, and Professor Rautenstrauch, his paper on Design of Curved Machine Members. The discussion on both papers proved of great value, the lantern slides shown in the discussion of Professor Lanza's paper adding much to its interest. A number of authorities on reinforced concrete design and construction had expressed a desire to discuss Professor Lanza's paper and much valuable information was brought out regarding the present state of the art. Those discussing

the paper were Sanford E. Thompson, E. P. Goodrich, Professor Rautenstrauch, Prof. W. H. Burr, B. H. Davis, of the Lackawanna Railroad, who showed slides of a number of concrete arches in railroad work; C. B. Grady of the New York Edison Company, who showed slides of beams and floor slabs under test; F. B. Gilbreth, who showed slides of the longest concrete beam of a rectangular section ever built in a roof, as well as other beams which had successfully passed through the fire and earthquake of the San Francisco disaster. Contributed discussions by Prof. J. C. Ostrup, E. L. Heidenreich, and C. E. Houghton were also presented. Professor Rautenstrauch's paper was discussed by a number of authorities on machine tool design, as follows: Professor Lanza, Chas. R. Gabriel, George R. Henderson, Professor Burr, Herman A. Knoener, and Carl G. Barth. Those submitting written discussions were: C. E. Houghton, A. L. Campbell, H. Gansslen, F. I. Ellis, E. J. Loring and John S. Myers.

MEETING OF THE COUNCIL

A meeting of the Council was called to order at 3 p.m., November 9, 1909, in the rooms of the Society, Jesse M. Smith, President, presiding. There were present: Messrs. Miller, Hunt, Gantt, Swasey, Carpenter, Stott, Riker, Wiley, Moultrop, Breckenridge and the Secretary. Regrets were received from George M. Bond.

The Secretary reported the death of Lewis C. Grover.

EXECUTIVE COMMITTEE

The Chairman reported the forwarding of the formal acceptance of the invitation of the Institution of Mechanical Engineers and that the invitation and acceptance were to be printed in a circular letter soon to be sent to the entire membership, together with a reply postal card, to ascertain how many members were going or hoped to go to England next year, as well as those who know they cannot go.

AMENDMENTS TO BY-LAWS AND RULES

Notice of proposed amendment to By-Law B 13–36–34 was given.

Voted: That the matter of amendment to C–18 and B–18 be referred to the Finance Committee.

Voted: To approve the following amendment to Rule 4.

R–4 Each paper which has been accepted by the Committee on Meetings for presentation at any meeting of the Society shall be published in The Journal at least seven days in advance of that meeting and in the form in which it has been

accepted by that Committee, and that paper shall also be distributed in pamphlet form at that meeting. A paper received too late for such distribution shall only be accepted for presentation at that meeting by unanimous consent of the Committee on Meetings, and shall if so accepted be published in a subsequent issue of The Journal. A member may by letter signify his intention to discuss any of the papers and unless otherwise directed by the presiding officer priority in debate shall be given in the order of the receipt by the Secretary of such notification.

MACHINE SHOP SECTION

Resolutions of the Committee were presented, expressing the accord and sympathy of the Council with those seeking to give special prominence to papers and discussions on the machine shop and related topics and its approval of a policy whereby the individual activity of members interested in special topics of practice or discussion may be enlisted. To this end the Council will favor the creation of subcommittees of members of the Society, under the general direction of the Meetings Committee, to assist that Committee in procuring papers, the holding of meetings for their discussion, and the stimulation of activity and interest along such special lines.

Voted: That the report of the Executive Committee with respect to a Machine Shop Section be adopted and referred to the Meetings Committee, for their recommendations.

STUDENT BRANCHES AND RULES

Voted: To adopt the Committee's report on Student Branches, containing the following resolutions:

That the Secretary be authorized by Council to take all necessary preliminary steps when the application for a student branch comes from any university, college or technical school authorized by charter to give degrees in engineering or applied science and which has a member or members of the Society in its faculty, who shall join in making such application. Such a Student Branch must have an enrollment of at least fifteen students; must make application to the Council on a blank provided by the Secretary, this blank to receive the signature of approval of said member of the faculty and also that of the dean or executive head of the institution; and must file with the Secretary a copy of its Constitution and By-Laws, together with an agreement to comply with the rules and requirements of the Society during the existence of their relationship.

Resolved: That the printed list of Committees in the Year Book contain a Committee on Student Branches and that until further action Prof. F. R. Hutton, Honorary Secretary, be appointed such Committee.

The Executive Committee shall have power to direct the Secretary to organize such a Student Branch when the foregoing requirements have been complied with, and shall report such action to the Council.

Voted: That the Council approve the applications of the following student bodies, as recommended by the Executive Committee, to become Affiliate Branches of the Society: University of Illinois, Pennsylvania State College, New York University, Massachusetts Institute of Technology, University of Cincinnati, University of Wisconsin, and Columbia University.

MEETINGS COMMITTEE

The Secretary reported that the Council had passed resolutions, authorizing the Meetings Committee to establish meetings in different cities, on the same basis as those held monthly in New York, but subject to the approval of the Executive Committee and Council.

The question of the necessity of this approval in each case was considered and it was

Voted: That the Council approve the meetings that have already been held in cities other than New York, and which have already been approved by the Executive Committee; and further

Voted: That the whole subject of all monthly meetings of the Society be referred to the Committee on Meetings, with full power.

PUBLICATION COMMITTEE

The report of the Publication Committee with respect to the Year Book was adopted, with amendments, as follows:

Voted: To publish the Year Book once a year in February; that the next issue be the standard club-book size, to be issued with complete alphabetical list and with abbreviated geographical list, giving the minimum information necessary in order to address a man at his firm, or his home in case he has no business address. Make-up of book to be changed to the list of officers and Standing Committees first, list of members, and finally Constitution and By-Laws; including a picture of the building.

It was further

Voted: That the design of the cover of the present Year Book be adopted as the style of the outside cover of all succeeding Year Books, but reduced in size.

FINANCE COMMITTEE

The Finance Committee recommended to the Council that, in the absence of the President or the Treasurer, one of the Vice-Presidents be appointed Assistant Treasurer, to sign checks duly authorized by the Finance Committee. It was

Voted: To defer the appointment of an Assistant Treasurer to the first meeting of the Council under the new administration.

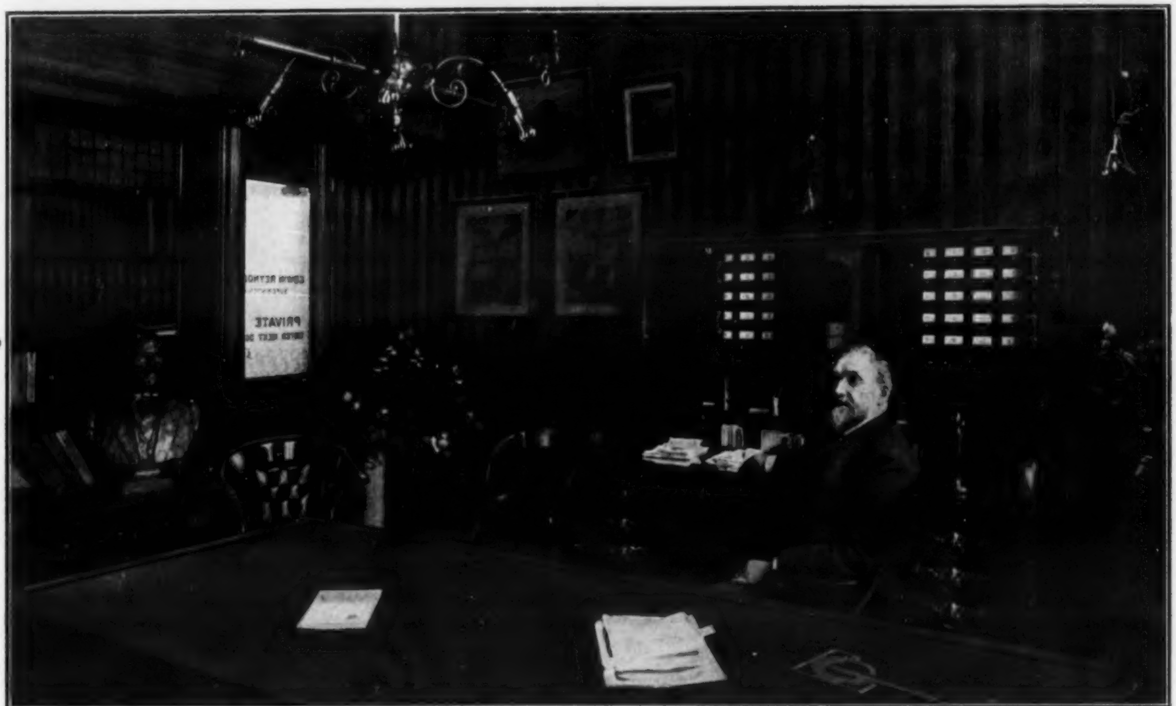
ANNUAL REPORTS OF STANDING COMMITTEES

The Secretary presented annual reports of the Standing Committees The reports of the Finance Committee and of the Auditors were adopted and ordered printed in The Journal. It was further

Voted: That the reports of all the Standing Committees be published in The Journal. The meeting adjourned.

ACCESSIONS TO THE LIBRARY

The list of accessions to the library which is published in each issue of The Journal includes only those volumes or pamphlets which have been added by gift, exchange or purchase to the individual library of The American Society of Mechanical Engineers, included in the United Engineering Library. A list of the accessions to the libraries of the American Institute of Mining Engineers and the American Institute of Electrical Engineers, also included in the joint library, may be secured upon request of the Secretary of the Society.



EDWIN REYNOLDS, PRESIDENT AM.SOC.ME., 1902

MR. REYNOLDS IS SEATED AT THE DESK JUST PRESENTED BY MRS. REYNOLDS TO THE SOCIETY

EDWIN REYNOLDS DESK

The Society has just received as an addition to the furniture of its rooms a very valuable desk of extraordinarily fine workmanship, which belonged to Edwin Reynolds, President of the Society for 1902. The desk was presented to the Society by Mrs. Reynolds on her husband's death, February 19, 1909, and will be kept in the rooms for the use of each successive president.

The desk is a roll-top desk of solid mahogany, natural finish, six feet long and high, and elaborately and beautifully carved. It was made in Antwerp and took several prizes for design and workmanship abroad and in America. Its value is probably $1500.

The desk was presented to Mr. Reynolds on the occasion of his seventieth birthday by his associates of the Edward F. Allis Company, afterwards the Allis-Chalmers Company, of Milwaukee, Wis., of which he was then a vice-president and superintendent. Accompanying the gifts was the following memorial, which will be preserved with the desk.

Milwaukee, Wisconsin
March 23, 1901.

Mr. Edwin Reynolds, 2d Vice Pres. & Supt. of The Edward P. Allis Company,

It is our pleasure in behalf of the Employees of this Company which includes all from the President to the latest Apprentice to present to you on this your 70th Birthday this Desk, together with the Chairs, Table and Rug which complete the furnishing of your office.

The founder of this business, Edward P. Allis, started its career in 1860 with 35 employees. When you became associated with it in 1877 there were about 300 workers within its walls. Today after nearly a quarter century of your able superintendency, you see around you 2500 earnest strivers after its success, and all united in wishing you God speed in whatever the future may bring to you.

In making the presentation it is the sincere desire and earnest wish of all that these tokens of our good will may occupy their present quarters with your honored self enjoying them for long years to come, but should your best interest require that your labors be put forth in another field, or that you should take a well deserved rest, these mementoes accompanying you, will still be a daily reminder of the friendship and esteem of your co-workers, who these many years have labored and wrought with you in the upbuilding of these works.

That the years of your life may only be numbered when their usefulness and enjoyment is completed, is the sincere and earnest wish of all

The Committee.

REPORTS ON STANDING COMMITTEES TO THE COUNCIL

REPORT OF THE FINANCE COMMITTEE

The Committee submits the statements of the financial condition of the Society, together with the report of Peirce, Struss & Co., of New York, certified public accountants, who have audited the books and accounts.

PEIRCE STRUSS & CO.
CERTIFIED PUBLIC ACCOUNTANTS
37 Wall Street, New York

November 8, 1909

MR. ARTHUR M. WAITT,
CHAIRMAN FINANCE COMMITTEE

Dear Sir:

In accordance with your instructions, we have audited the books and accounts of The American Society of Mechanical Engineers for the year ended September 30, 1909.

The results of this examination are presented in three exhibits, attached hereto, as follows:

Exhibit A Balance Sheet, September 30, 1909.

Exhibit B Income and Expenses; based on Cash receipts for year ended September 30, 1909.

Exhibit C Receipts and Disbursements for year ended September 30, 1909.

We beg to present, attached hereto, our certificate to the aforesaid exhibits.

Respectfully submitted,
PEIRCE, STRUSS & CO.
Certified Public Accountants

PEIRCE, STRUSS & CO.
CERTIFIED PUBLIC ACCOUNTANTS
37 Wall Street, New York

November 8, 1909

MR. ARTHUR M. WAITT,
CHAIRMAN FINANCE COMMITTEE

Dear Sir:

Having audited the books and accounts of The American Society of Mechanical Engineers for the year ended September 30, 1909, we hereby certify that the accompanying Balance Sheet is a true exhibit of its financial condition as of September 30, 1909, and that the attached statements of Income and Expenses, and Cash Receipts and Disbursements, are correct.

PEIRCE, STRUSS & CO.
Certified Public Accountants

EXHIBIT A

Balance Sheet, September 30, 1909

ASSETS

Equity in Societies Building (25 to 33 West 39th Street)	$353 346.62	
Equity, one-third cost of land (25 to 33 West 39th Street)	180 000.00	
		$533 346.62
Library Books	$13 700.60	
Furniture and Fixtures	2 966.96	
		16 667.56
New York City 3½ % Bonds 1954, Par, $35,000	$30 925.00	
Cash in Bank representing Trust Funds	12 918.39	
		43 843.39
Stores including plates and finished publications		11 600.00
Cash in Bank for general purposes	$7 444.83	
Petty Cash on hand	250.00	
		7 694.83
Accounts Receivable		
Membership dues	$4 924.50	
Initiation fees	285.00	
Sale of publications, advertising, etc	4 334.55	
		9 544.05
Advances account of land subscription fund		7 960.94
Advanced payments		2 214.15
Total assets		$632 871.54

LIABILITIES

United Engineering Society (for cost of land)		$81 000.00
Funds		
Life membership Fund	$35 151.07	
Library Development Fund	4 902.71	
Weeks Legacy Fund	1 957.00	
Land Fund Subscriptions	1 227.88	
Robert H. Thurston Memorial Fund	399.13	
Subscriptions to Annual Meeting	205.60	
		43 843.39
Current Accounts Payable		11 163.00
Membership dues paid in advance	$494.50	
Initiation fees paid in advance	50.00	
		544.50

Initiation fees uncollected	$285.00
Reserve (Initiation fees)	24 596.97
Surplus in property and accounts receivable	471 438.68
Total Liabilities	$632 871.54

EXHIBIT B

INCOME AND EXPENSES BASED ON CASH RECEIPTS FOR YEAR ENDED SEPTEMBER 30, 1909

INCOME

Membership dues, current	$50 273.79	
Membership dues, arrears	2 355.00	
Sales gross receipts	8 847.39	
Advertising receipts	11 997.50	
Interest and Discount	1 234.68	
Reserve Fund, 10%	3 010.77	
		$77 719.13

EXPENSES

Finance Committee Office Administration including Salaries	$19 971.91	
Finance, United Engineering Society Assessments	6 000.00	
Finance, miscellaneous	983.56	
		$26 955.47
Membership Committee		2 392.36
Increase of Membership Committee		147.94
House Committee[1]		1 192.43
Library Committee		2 699.17
Meetings Committee		
Annual Meeting	$2 074.24	
Spring Meeting	1 410.52	
Monthly Meetings	2 278.19	5 762.95
Publication Committee		
Advertising Section The Journal	$7 026.06	
Journal, except Advertising	13 134.80	
Pocket List	1 599.59	
Revises	523.93	
Transactions, Vol. 30	6 533.87	
Year Book	1 401.30	
History	43.65	
		30 263.20

[1] From Current Income $1192.43
Reserve Fund 2500.00

Total Expenses 3692.43

Research Committee	$0.58	
Committee on Power Test	11.25	
Sales Expenditures	4 060.99	
		$73 486.34
Excess of Income over Expenses		4 232.79
		$77 719.13

EXHIBIT C

Receipts and Disbursements for Year Ended September 30, 1909

RECEIPTS

Membership dues	$50 832.70	
Initiation fees	6 460.00	
Membership dues and initiation fees paid in advance	551.00	
Sales of publications, badges, advertising, etc	20 833.25	
Subscriptions to Land Fund	3 251.00	
Subscriptions to Expense of Annual Meeting	2 188.00	
Interest	2 072.24	
John Fritz Medal	123.74	
Cash Exchanges per contra	575.92	
	$86 887.85	
Cash in Banks and on hand, September 30, 1908	13 708.98	
		$100 596.83

DISBURSEMENTS

Disbursements for general purposes	$76 167.69	
Interest on Mortgage on land	3 240.00	
Cash Exchanges per Contra	575.92	
	$79 983.61	
Cash in Banks and on hand, September 30, 1909	20 613.22	
		$100 596.83

The Committee also submits as called for by the By-Laws a detailed estimate of the probable income and expenditure of the Society for the Fiscal year ensuing. This estimate has been submitted to the careful consideration of each committee concerned and the Finance Committee has been assured in each instance that the appropriations asked for in the estimate include all needed expenditures to carry out the work of the different committees as now planned and authorized.

It will be noted that the Society is not being operated for profit, but that practically all of the money received is appropriated for the development of the Society's various interests, and to enable giving to each member a constantly increasing return for his membership dues.

ESTIMATE, 1909-1910

Current Income		Current Expenses	
Dues, Current	$52000	Finance Committee	$26000
Dues, Arrears	2000	Membership Committee	2400
Reserve Fund, 10 %	2800	Increase Memb. Committee	500
Sales gross receipts	5000	House Committee[1]	1150
Interest	800	Library Committee	2880
Advertising	21000	Meetings Committee	8050
		Publication Committee	34900
	$83600	Research Committee	500
		Executive Committee[2]	600
		Power Tests Committee	500
		Sales Expenditures	3000
			$80480
		Excess of income over expense	3120
			$83600

[1] In addition $3000, to be appropriated from the Reserve Fund for the House Committee for betterments for 1909-1910.

[2] The appropriation for the Executive Committee for the foreign meeting to be $3000, to be divided from Current Income at not less than $600 per year for a term of years until cancelled.

Especial attention of the Council is called to the fact that in connection with entering upon our occupancy of the present refined and dignified headquarters, a large sum was advanced from the Society's working capital, known as the Reserve to the Land and Building Fund from which fund by vote of the Council the interest on the mortgage for the land is paid. Admittedly the Society cannot afford to pay for the present headquarters out of its current income unless the Society is freed from debt; and it was with the understanding that sooner or later this debt would be raised, that the Society was justified and enabled to accept the gift from Mr. Carnegie. During the past year the total receipts to the Land and Building Fund have been practically used up for paying the interest on the mortgage, without decreasing the total of the mortgage to the extent of one dollar.

The Finance Committee observes that it has been the custom, by ruling of the Council, to take 10 per cent of the Reserve Fund each year to be applied to the payment of current expenses; and they recommend to the Council that this custom be discontinued, and that the total payments into the Society of initiation fees, which go to make up the Reserve Fund, shall remain in the Reserve, and that only by special vote of the Council shall money be expended from this Reserve.

The Finance Committee trusts that the time is opportune for the Land and Building Fund Committee to take steps during the coming year to raise a portion if not all of the indebtedness amounting to about $90,000.

It is highly desirable in view of plans for broadening the work of the Society that our income available for such extension of work be increased. The organization of our Society is such that the Finance Committee is charged solely with the responsibility of administering the Financial affairs of the Society as they find them and not to produce revenue. All the remaining activities of the Society are for the expenditure of revenue. The Finance Committee suggests therefore that it would be in keeping with good management if a special committee was appointed to consider the essential feature of the Society's broader life, viz: the income side, and to see that it is increased to provide for the reduction caused by the discontinuance of taking 10 per cent annually from the Reserve for operating expenses and to provide for a broader work in the future.

Respectfully submitted

ARTHUR M. WAITT, *Chairman*
EDWARD F. SCHNUCK
GEORGE J. ROBERTS
ROBERT M. DIXON
WALDO H. MARSHALL
Finance Committee

REPORT OF THE HOUSE COMMITTEE

The House Committee reports that it has endeavored to make the headquarters of the Society more attractive, by a rearrangement of the rooms and by additions to the furnishings.

When the Society entered its new headquarters nearly three years ago, provisional furnishings were purchased sufficient to carry on the business of the Society but with no attempt at decorative features.

The original plans of the rooms provided for a large reception hall which visitors enter from the elevators. In common with the other floors of the building this hall was open to the main stairway.

A partition cutting off this stairway and another partition separating the offices has converted this hall into an excellent reception room.

Sliding doors have been arranged so that the Council Room, the Library and the Secretary's office give the effect of one large and spacious room.

The walls have been retinted, and new rugs cover the floors. Comfortable furniture has been placed in the reception room. There will be portieres between the rooms, draperies at the windows, and more comfortable chairs and divans added to the library and Council chamber.

The Committee has aimed to make the rooms homelike and comfortable, to make a place which the members will use freely for their own convenience and for meeting other members or friends for social or business engagements.

In addition to the large rooms referred to, a small room is especially reserved where members may attend to their correspondence or hold private conferences.

Photographs of the Past-presidents have been placed on the walls of the Library and by order of the Council a similar portrait of each succeeding President will be added as he retires from office. Nameplates have been placed on the portraits, paintings and historical objects, and a very complete catalogue of all these objects of historical interest has been prepared. This catalogue represents the result of long and painstaking research on the part of Mr. Edward Van Winkle of our Committee.

Respectfully submitted,

HENRY S. LOUD, *Chairman*
W. C. DICKERMAN
B. V. SWENSON
FRANCIS BLOSSOM
EDWARD VAN WINKLE

House Committee

REPORT OF THE LIBRARY COMMITTEE

During the past year further steps have been taken in the evolutionary process of administering the libraries of the American Institute of Mining Engineers, the American Institute of Electrical Engineers and that of our own Society, as far as practicable, as a unit.

This process has involved the development of a comprehensive plan whereby the library of each society maintains only books on subjects in which its membership is particularly interested, treating all other publications in its library as duplicates. To the American Institute of Mining Engineers have been assigned the subjects of mining engineering, geology, mineralogy, chemistry, metallurgy and a part of chemical technology. To the American Institute of Electri-

cal Engineers the subjects of electrical engineering, electricity, physics, mathematics and pure science; and to this Society the subjects of general engineering, railroad engineering, mechanical engineering, civil engineering and a part of chemical technology. This plan has given satisfaction as a temporary working basis enabling each organization to complete or supplement imperfect sets from the collections of the others.

During the year a union card catalogue has been established, covering the libraries of the three Founder Societies, which enables readers to find at a glance all the literature on any subject that may be contained in any of the libraries.

A Library Conference Committee, consisting of the Chairmen of the Library Committees of the three societies, has under consideration a further important step toward the unification of the three libraries, involving the organization of the library of the United Engineering Society, to which the three societies shall bear the same relation as do the Founder Societies in the holding of the United Engineering Societies building and property. Such a plan will enable gifts of books or periodicals not specifically designated for one society to be received and taken care of and it may eventually result in the purchase of books jointly in which the three Societies would have a common ownership. This plan avoids purchases in triplicate or duplicate and concentrates the purchasing power and extension of the library in a way that will be of undoubted advantage to all who may have occasion to consult a comprehensive library of engineering literature, covering all branches of the profession and having available promptly after publication all the important books.

It is probable that these improvements will necessitate the carrying out of the original building plans for the library, providing additional shelving in the library room proper, so that all of the volumes may be readily accessible.

The present status of the Library of The American Society of Mechanical Engineers is as follows:

The following titles have been catalogued to date:

Durfee library	570	vol.
A. S. M. E. library	7237	"
Withdrawal of duplicates (not accessioned)	800	"
Pamphlets	1339	"
Total	9946	"

The additions provided for 1908–1909 and included in the above are as follows:

By gift	168	vol.
By purchase	95	"
By binding of exchanges	197	"
Total accessions	460	"

Respectfully submitted,

J. W. LIEB, JR., *Chairman*
C. L. CLARKE
H. H. SUPLEE
AMBROSE SWASEY
LEONARD WALDO
Library Committee

REPORT OF THE MEETINGS COMMITTEE

To facilitate the work of the present Committee, and it is hoped, of succeeding committees, a record has been made of its policies and decisions, some of the more important of which are given below:

The policy of the Committee shall be:

1 Further condensation of papers by the elimination of all superfluous and irrelevant matter, or matter previously printed, and of such statements of fact as are of common knowledge in the profession.

2 The solicitation and selection of such papers, together with the plan of their presentation at meetings, as may make the Transactions a historical and up-to-date record of the progress of all branches of mechanical engineering.

3 The presentation of a subject, whenever possible, in such a way as best to permit of a general and thorough discussion; and to this end to extend invitations to those, whether members or otherwise, whose experience has been such as to bring out the most valuable discussion of the subject.

4 At the Annual and Semi-Annual Meetings, a reduction, when possible, of the number of professional sessions, and of the number of papers assigned thereto in order that more opportunity may be given for satisfactory discussion and for social intercourse between the members. It is the opinion of the Committee that the professional sessions heretofore have been too crowded.

5 For the sake of uniformity, the adoption of a few rules for the guidance of authors, these to be based on the experience of the Committee and of the editorial department of the Society, and to offer a review of the rules governing similar organizations.

6 The adoption of rules tending towards greater uniformity in the actions of the Commitee; these rules to be such only as concern actions within the jurisdiction of the Committee and subject to such exceptions as in the opinion of the Committee may seem desirable.

During the past year, the Committee has submitted to the Council a number of suggestions relative to changes in some of the methods of conducting such affairs of the Society as relate to the Meetings Committee. All of these, with slight modifications, have been accepted and endorsed by the Council and so far as possible placed in operation.

The selection of a local committee to take charge of all entertainment, apart from the professional sessions, was tried at the last Annual Meeting with satisfactory results, which we believe long-established practice will make even better. This is creating greater interest among the local members, and a feeling of some responsibility for the entertainment of the visiting members, and places the Annual Meeting upon the same basis as the Spring Meeting, thereby eliminating what has been heretofore a somewhat inconsistent situation. The Social and Entertainment Committee will for the first time this year collect and disburse the fund for this purpose, which will be kept separate and apart from the funds of the Society. This phase of the arrangement cannot be otherwise than satisfactory.

The resolution of the Committee submitted to the Council, relative to meetings in mid-season in cities other than New York, was put into operation immediately upon approval by the Council. In the opinion of the Committee, this movement is progressing very satisfactorily and seems to be assuming a natural, healthy growth. The object of the resolution is outlined in The Journal for June 1909, pp. 17–19. Successful meetings were held at Boston, April 16, June 11, October 20, and November 17; and at St. Louis, April 10, May 15, October 16, and November 13. This movement, as was desired and anticipated, is bringing before the Society much valuable material in the form of papers and especially of discussion that would otherwise be inaccessible to the members. It has resulted in an exchange of papers, which promises to become more extensive in the future.

The Council's amendment to the Committee's resolution, "subject to the approval of the Council," we find from experience to be cumbersome. To facilitate these meetings, the Committee must act promptly upon request from members residing in places other than New York. With the appropriations for these meetings decided upon the Committee urges that the Council modify its instructions to the effect that the Committee may have full authority in compliance with the original resolution submitted by the Committee to the Council.

The Committee's interpretation that B-21 did not include the vouchering of bills covering the expenditures of the appropriations for its work, has been confirmed by the minutes of the Council of a

few years ago, when the details of such expenditures were placed in the Secretary's hands as business manager. The rules governing office procedure have, however, been changed to define more clearly this interpretation, resulting in some simplification of the work of the accounting department.

Last spring a number of members of the Society requested a meeting or conference on the subject of Smoke Abatement. This petition and the action of the Committee were referred to the Council on May 28, 1909. This request was for a National Conference with the elimination of the engineering features as far as possible. After due consideration the Committee declined to take favorable action.

Subsequent to the above, the Committee received a second petition asking for a National Conference, but along strictly engineering lines. In the absence of precedent relative to such a Conference, the Committee referred the question to the Council. The Committee has not received, but would gladly receive and carefully consider, a paper on the subject of Smoke Abatement, if presented along strictly engineering lines.

We believe the best interests of the Society make necessary a close working arrangement between the Research and Meetings Committees.

A plan was inaugurated early in the year which it is thought will bring before the Society more new material than has been heretofore available. This is accomplished by correspondence with those interested in original research.

The usual number of meetings were held by the Society during the past year, all of which are now on record. The Committee begs to express its appreciation for the assistance and coöperation during the year of the officers and the several departments of the Society.

Willis E. Hall, *Chairman*
William H. Bryan
L. R. Pomeroy
Charles E. Lucke
H. deB. Parsons

Meetings Committee

REPORT OF THE MEMBERSHIP COMMITTEE

During the current year the Membership Committee has held seven meetings, at which a total of 361 applications for membership have been considered with the following results:

Applications void and withdrawn	11
Applications deferred	11
Recommended for membership	339

There were two ballots during the year on which the applicants recommended by the Committee were voted for. These were at the

Washington meeting	148
New York meeting	187
Total	335

In addition to the most careful consideration which the Secretary and the Membership Committee can give to the applications for membership, the coöperation of the whole voting membership is needed in order to maintain the high standing of the Society. In several instances during the year action by certain members in giving information to the Committee has caused reconsideration of applications, with the result that they have been indefinitely deferred.

A member should not agree to act as proposer or seconder for an applicant unless he actually knows from his own personal observation enough of the latter and his work to be able to answer favorably all the questions on the reference blank regarding him.

The Committee has endeavored to maintain under the By-Laws the standard of qualifications of applicants for whom they have recommended to be voted.

The work of the Committee has been greatly facilitated and expedited by the complete and admirable way in which the cases have been arranged by the Secretary and his staff for presentation to them.

Respectfully submitted,

Henry D. Hibbard, *Chairman*
Charles R. Richards
Francis H. Stillman
George T. Foran
Hosea Webster

Membership Committee

REPORT OF THE PUBLICATION COMMITTEE

The Publication Committee submits herewith the annual report of its work and of the activities under its control for the past year.

The Committee has held frequent meetings and has earnestly endeavored not only to maintain the high standard for the publications of the Society which has previously been set, but also wherever pos-

sible to raise the standard to a new level. In its work upon Volume Thirty of the Transactions which contains the record of the Spring and Winter meetings of 1908, the Committee has given careful study to the available papers with a view of selecting for that volume only those of greatest value for permanent record. After due consideration several papers have been omitted and others have been edited or revised with the approval of the authors. Discussions also have been edited and in some cases considerably condensed in order to separate material of permanent value from that which had but a temporary or passing interest.

In compliance with the Resolutions passed by the Council in April 1909, the Publication Committee has undertaken the general supervision of The Journal in addition to its other duties, and has adopted the following general plan for the conduct of this work:

As a general policy, The Journal should be regarded as the newspaper of the Society and reports of committees, reports of meetings, professional papers of the Society as a whole or of sections, book reviews, Society items, etc., should be published as requested by committees in their official capacity when approved by this Committee, without charging to the committees or activities concerned any expense for publication. The Journal has its own expense account and the appropriation for The Journal should be sufficient to cover editing and publication of this material.

No papers, whether for the meetings of the Society as a whole, or for sections, technical, student or geographical, are to be published except as formally authorized by the Meetings Committee.

Material from standing committees offered officially will, in general, be published in the form which these committees desire.

Reports of meetings of the Society and of sections, except when containing strictly professional papers and discussions will, in general, be published in condensed form.

All matter presented at meetings other than the professional papers provided by the Meetings Committee, including all discussions, will be edited under the direction of the Publication Committee. As a general policy, discussion will be condensed, commercial matter removed, with a view to presenting only engineering data, opinions based on experience, historical notes and similar material of value for permanent record in Transactions.

The advertising section of The Journal which began with the number of September 1908, has proven successful. The income from this source has increased steadily until at the present time there is a

gross annual income from it of $21,000; and through the action of the Council this increased income may be applied to the improving of the quality of, and to the development of The Journal. Plans for such development are under consideration, and it is the purpose of the Committee to make improvements as rapidly as conditions may warrant.

But the most effective work upon the Journal and that which will be of greatest benefit to our membership at large is the careful preparation for publication of the professional material presented at the regular meetings of the Society, and at the meetings of the different sections. In this great fund of material there is always some that is unimportant and irrelevant, and much more that could be made of greater value by skilful editing or by condensation. During the past year the Committee has done much in this direction that has resulted in the improved quality of our paper, and also in a considerable economy of money, and the papers now appearing in The Journal are suitable, with little or no alteration, for publication in the Transactions.

In addition to the volume of the Transactions and The Journal the Committee has issued the annual Year Book of the Society and the Pocket List of Members.

Respectfully submitted,

A. L. WILLISTON, *Chairman*
D. S. JACOBUS
H. F. J. PORTER
H. W. SPANGLER
G. I. ROCKWOOD
} *Publication Committee*

REPORT OF THE RESEARCH COMMITTEE

The Research Committee was formally notified of their appointment under date of April 7, 1909, and at the suggestion of the President, the members were requested to meet during the Spring meeting of the Society at Washington. Notice was given a short time in advance of the meeting, and only Prof. R. C. Carpenter and Mr. R. H. Rice were present. These members, however, together with the President of the Society, Jesse M. Smith, and Charles W. Hunt, Past-President, and originator of the suggestion that a Research Committee be appointed, engaged in an informal conference.

A second meeting was called for Wednesday, June 23, 1909, to be held in New York. There were in attendance the President, R. H.

Rice, James Christie, W. F. M. Goss, and the Secretary, Calvin W. Rice. Dr. Goss was chosen Chairman. The Secretary of the Society was recognized as the secretary of the Committee. The minutes of the informal meeting which was held in May were read for the information of the members. After a considerable discussion as to the scope of the work of the Committee, it was agreed that the Committee should have information concerning the laboratories of the various colleges, and other public institutions in America, in which work of engineering research is proceeding, and to this end the Secretary was directed to develop a process which would result in the establishment of such a record in the office of the Society.

It was agreed that the Committee should consider the question of safety valve efficiency. Arrangements were made for gathering in existing information upon this general subject, and steps were taken which will, it is believed, result in a satisfactory outline from which actual work may proceed. Several other subjects for research, referred to the Committee by the Council, were laid on the table for future consideration.

Respectfully submitted

W. F. M. Goss, *Chairman*
James Christie
R. C. Carpenter
Richard H. Rice
Charles B. Dudley
} *Research Committee*

OTHER SOCIETIES

INTERNATIONAL CONGRESS OF MINING, METALLURGY, APPLIED MECHANICS AND PRACTICAL GEOLOGY

An inviation has been extended to the members of The American Society of Mechanical Engineers to attend the International Congress of Mining, Metallurgy, Applied Mechanics and Practical Geology, to be convened at Düsseldorf, June 20-23, 1910, in accordance with the request of the Rhenish-Westphalian Mining Industry made to the Congress of 1905. The 1910 Congress will be divided into four sections, (1) mining, (2) metallurgy, (3) applied mechanics, (4) practical geology. There will be both general and sectional meetings, visits to scientific institutions, industrial undertakings, etc., and excursions to districts of geological interest.

The provisional program includes papers on the Mechanical Preparation of Coal and Ore, the Recovery of By-Products, Briquetting and the Utilization of Low-Grade Fuels; the Production of Pig and Malleable Iron; the History of Machine Construction for Mining and Metallurgical Purposes; Steam Raising; Central Electric Power Stations, Fans and Air-Compressors; Blowing Engine for Blast-Furnaces and Steel Works; Methods of Driving Rolling Mills; Rolling Mills and Accessories; Conveyors for Mining and SmeltingWorks; and the Utilization of Natural Sources of Water Power.

AMERICAN SOCIETY OF CIVIL ENGINEERS

At the regular meeting of the American Society of Civil Engineers on November 3 at the clubhouse, 220 West 57th Street, New York, two papers were presented for discussion as follows: The Reinforced Concrete Wharf of the United Fruit Company at Bocas del Toro, Panama by T. Howard Barnes; and River Protection Work on the, Kansas City Southern Railway near Braden, Okla., by J. A. Lahmer.

On November 17, the papers discussed were: The Outlet Control of Little Bear Valley Reservoir, by F. E. Trask; and Water Supply for the Lock Canal at Panama, by Julio F. Sorzano, Mem. Am.Soc. M.E.

AMERICAN ASSOCIATION OF REFRIGERATION

At the final meeting of the American Committee of the First International Congress of Refrigerating Industries, held in the Engineering Societies Building, 29 West 39th Street, New York, on May 20, 1909, a permanent national association, styled the American Association of Refrigeration, was formally organized. Since the International Congress held at Paris last year national associations have been formed in Germany, Austria, France, Russia, The Netherlands and other countries. The purpose of the American organization is the facilitation of international intercourse on subjects pertaining to refrigeration and the securing of adequate American representation in international congresses, as well as the study and investigation of problems in refrigeration important to the industry in this country.

It is proposed to hold the Second International Congress of Refrigeration in Vienna, in September 1910, the reports of which will be published in English. Among the questions to be considered are various phases of industrial refrigeration, the application of refrigeration in the food and other industries, and transportation, low temperatures in physical, chemical and biological work, liquified gases, and the hygiene of refrigeration. A tentative program has been issued and can be obtained from the secretary of the American Association of Refrigeration.

It is possible that the Third International Congress of Refrigeration may be held in the United States.

WESTERN SOCIETY OF ENGINEERS

The Western Society of Engineers is now taking steps toward the organization of a Bridge and Structural Section, which, it is hoped, will be in operation in December.

The meetings of the Electrical Section are held jointly with those of the American Institute of Electrical Engineers, Chicago branch. At the first meeting, October 22, W. L. Abbott, Mem.Am.Soc.M.E., presented a paper on Central Station Economies. At the meeting of November 16, Dr. C. P. Steinmetz, Mem.Am.Soc.M.E., will address the meeting.

Among the papers yet to be presented during the winter are: The Panama Railroad and its Relation to the Panama Canal, by Ralph Budd; Progress of the Coal Mine Investigations by the U. S. Geological Survey, by G. S. Rice; River and Harbor Improvements at Chicago

and the Calumet, by Thomas H. Rees; Compressed Air in Contract Work, by M. W. Priseler; Reinforced Concrete Trestles, by C. H. Cartlidge; The Kilbourne Plant of the Southern Wisconsin Power Company, by D. W. Mead, Mem.Am.Soc.M.E.

CHICAGO ASSOCIATION OF COMMERCE

An engineering committee on electrification of railway terminals, appointed by the Chicago Association of Commerce, is composed of the following members: John M. Ewen, *Chairman*, Mem.Am.Soc.M.E.; W. L. Abbott, Mem. Am.Soc.M.E. ; B. J. Arnold; Paul P. Bird, Mem. Am.Soc.M.E.: Prof. W.F.M. Goss, Mem.Am.Soc.M.E., and Prof. C. E. Merriam.

PERSONALS OF THE MEMBERSHIP, AM. SOC. M. E.

Edwin E. Arnold, formerly associated with Farrar & Trefts, Buffalo, N. Y., has become identified with the Metal Products Co., Detroit, Mich.

Henry L. Barton has become associated with the Metal Products Co., Detroit, Mich., as vice-president. He was formerly manager of works of the Westinghouse Machine Co., E. Pittsburgh, Pa.

Harry Z. Bixler has become connected with Worth Bros. Company, Coatesville, Pa., as assistant engineer of the blast furnace department.

An article on The Advantages to Electric Companies of Central Station Steam Heating, by Chas. R. Bishop, was published in the October issue of *The Electrical Age*. This paper was read before the New England Branch of the National Electric Light Association, September 9–10, 1909.

W. H. Bradley has been elected president of the American Gas Institute.

Geo. L. Crook, formerly manager of the gas engine department of the Atlas Engine Works, Indianapolis, Ind., has assumed the position of factory manager of Plant No. 3 of the E-M-F Company, Detroit, Mich.

Alfred E. Forstall presented a paper on Sliding-Scale Regulation of Prices and Dividends at the October 20–21 convention of the American Gas Institute.

David Gaehr contributed a paper on Notes on Coal and Ash Handling Equipment at the November 19–20 meeting of the Ohio Society of Mechanical, Electrical and Steam Engineers.

Walter S. Hanson is president of the El Reno Alfalfa Milling Co., El Reno, Okla., a new company organized to build a mill and engage in the manufacture of alfalfa mixed feeds.

E. A. Hitchcock presented a paper on The New Laboratory of the Department of Mechanical Engineering at the Ohio State University, at the November 19–20 meeting of the Ohio Society of Mechanical, Electrical and Steam Engineers.

Edward C. Jones contributed a paper on The Development of Oil Gas in California at the October 20–21 convention of the American Gas Institute.

C. J. Kryzanowsky has become associated with the Reliance Motor Truck Co., Owosso, Mich., as chief engineer. He was until recently manager of the gas engine and producer department of the Olds Gas Power Co., Lansing, Mich.

H. G. Miller has accepted a position as mechanical engineer of the Rubber Regenerating Co., Mishawaka, Ind. Mr. Miller was formerly associated with the S. P. Pond Company, Keokuk, Ia., the Clarinda Poultry, Butter and Egg Co., Clarinda, Ia., and the Iowa Cold Storage Co., Clinton, Ia.

William Newell has prepared a pamphlet on The Prevention of Industrial Accidents, in collaboration with Frank E. Law.

H. F. J. Porter has given the first of his lectures in the graduate school of business administration of Harvard University. He is also a contributor in the correspondence course of instruction in the Hamilton Institute of Business recently established in this city by members of the Faculties of the New York University, the University of Wisconsin, the University of Philadelphia, etc.

Edwin C. Sornborger has become identified with the Allis-Chalmers Co. of Milwaukee, Wis., in the capacity of sales engineer in its pumping engine and hydraulic turbine department. Lieutenant Sornborger was formerly traveling engineer of the Snow Steam Pump Works, Buffalo, N. Y.

In the October issue of the Proceedings of the American Society of Civil Engineers is an article on Water Supply for the Lock Canal at Panama by Julio F. Sorzano. This paper was presented at the November 17 meeting of that Society.

Theodore Stebbins, formerly associated with the Texas Traction Company, and American Railway and Lighting Co., Dallas, Tex., has become a member of the firm of Herrick & Stebbins, with offices in New York.

C. P. Steinmetz gave a lecture on November 16, before a joint meeting of the Chicago Section of the American Institute of Electrical Engineers and the Electrical Section of the Western Society of Engineers, the subject being, The Conservation of Energy.

J. Stewart Thomson, formerly vice-president and treasurer of the New York Safety Steam Power Co., has associated himself with the Harrison Engineering Co., to develop the Harrison air-tube system of heating and ventilating, with offices in New York.

T. Kennard Thomson gave an informal library talk, illustrated with lantern slides, on Pneumatic Foundations, before the Brooklyn Engineers' Club on November 18.

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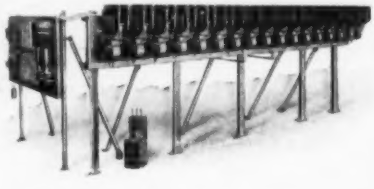

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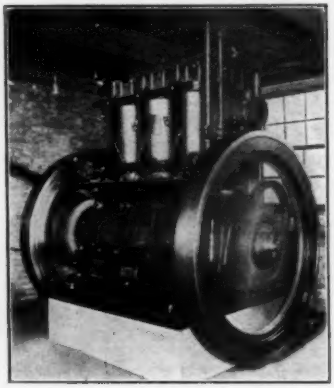

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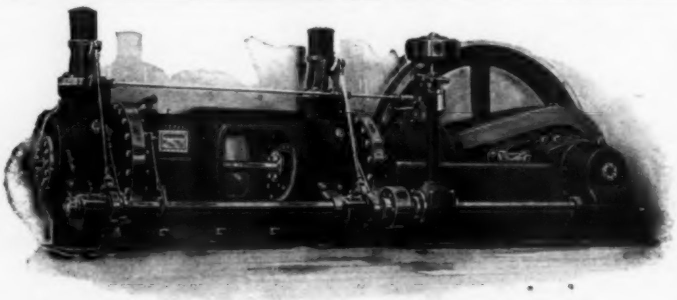

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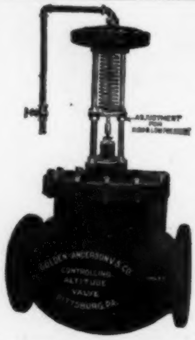

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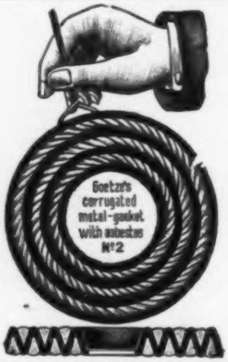

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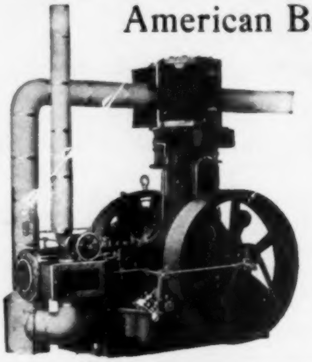

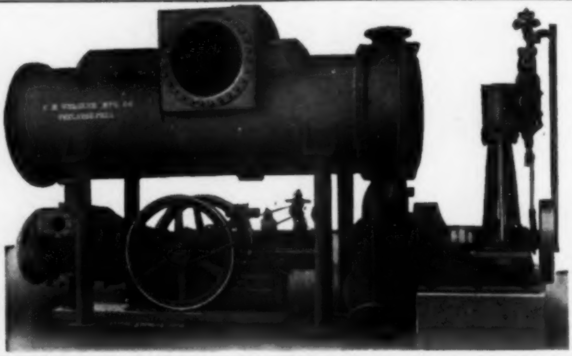

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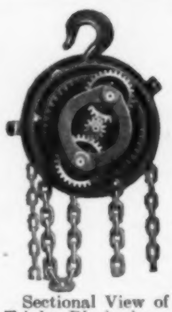

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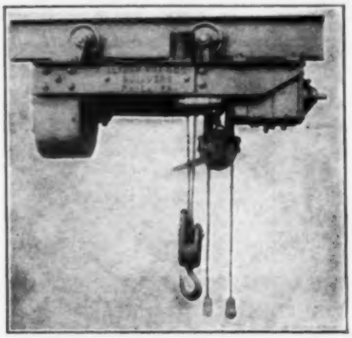

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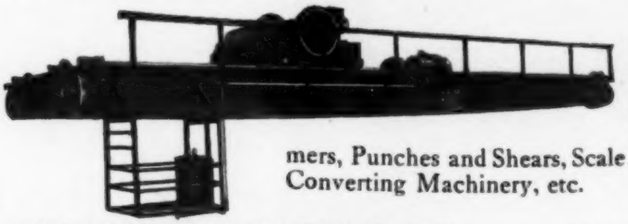

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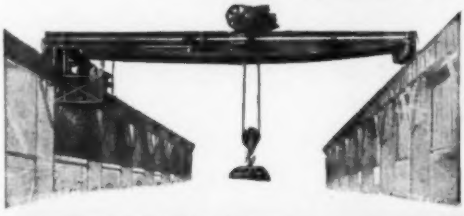

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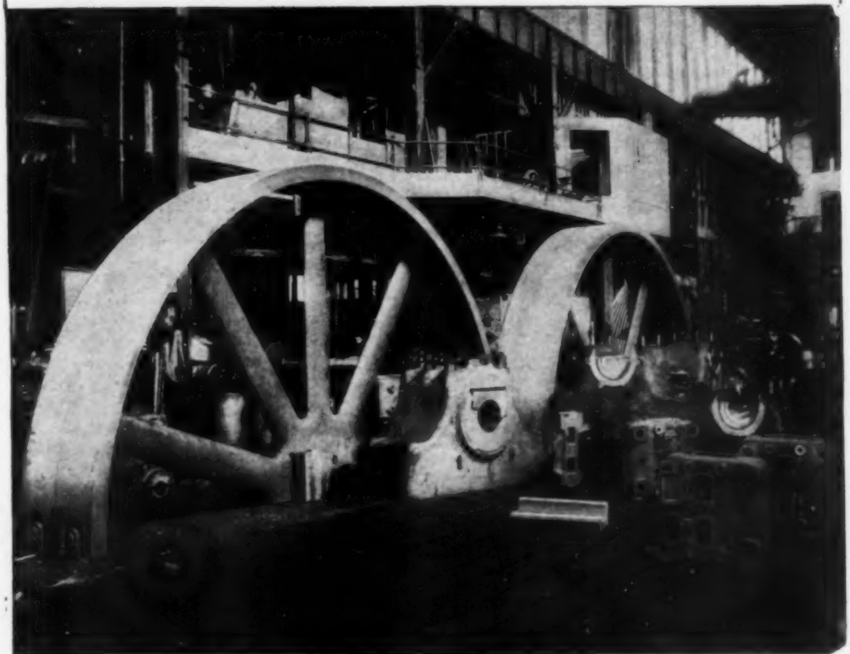

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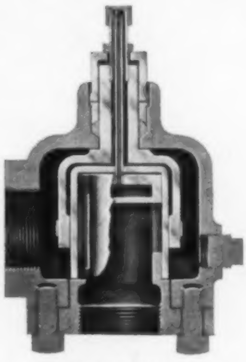

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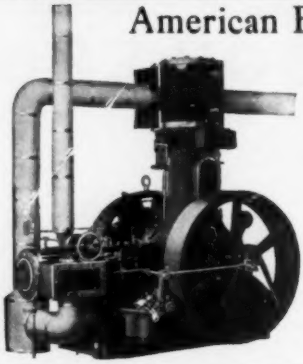

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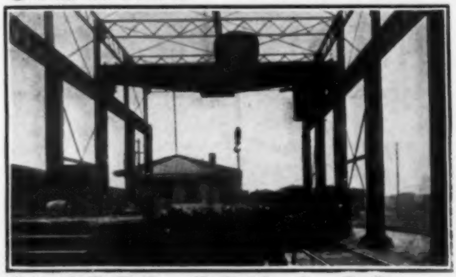

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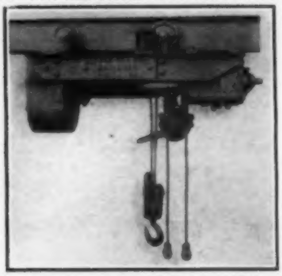

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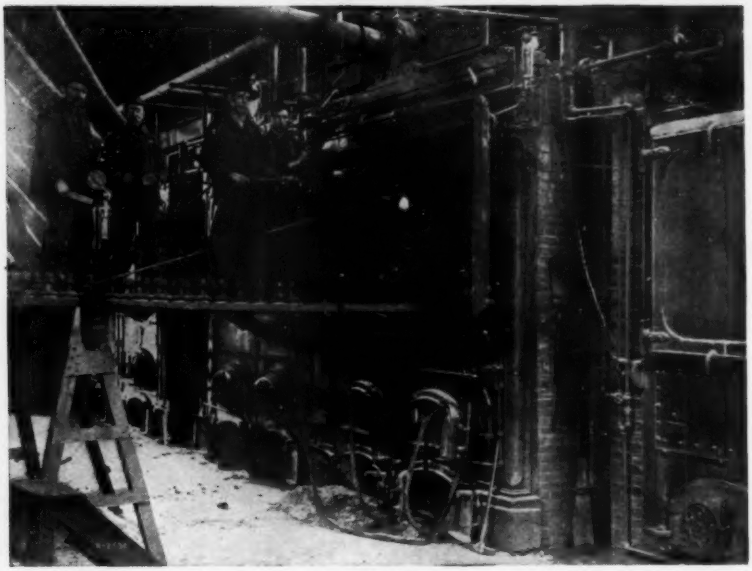

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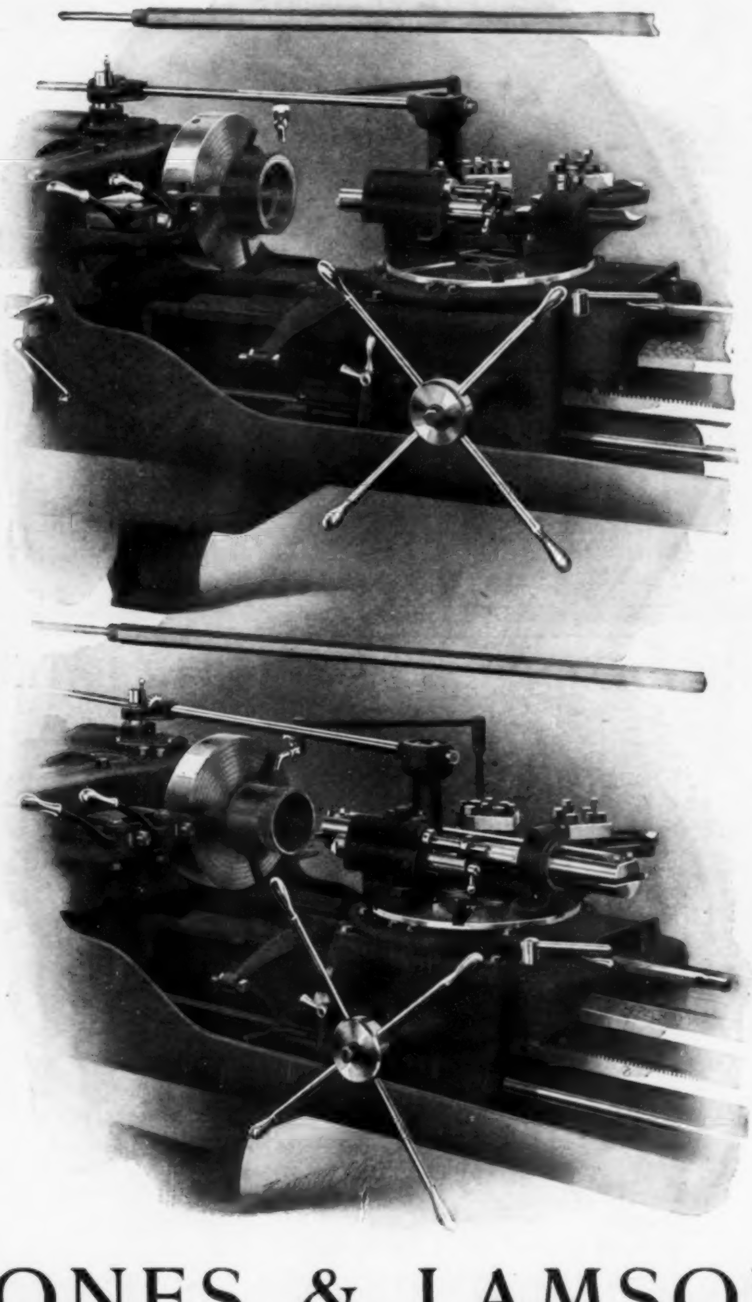

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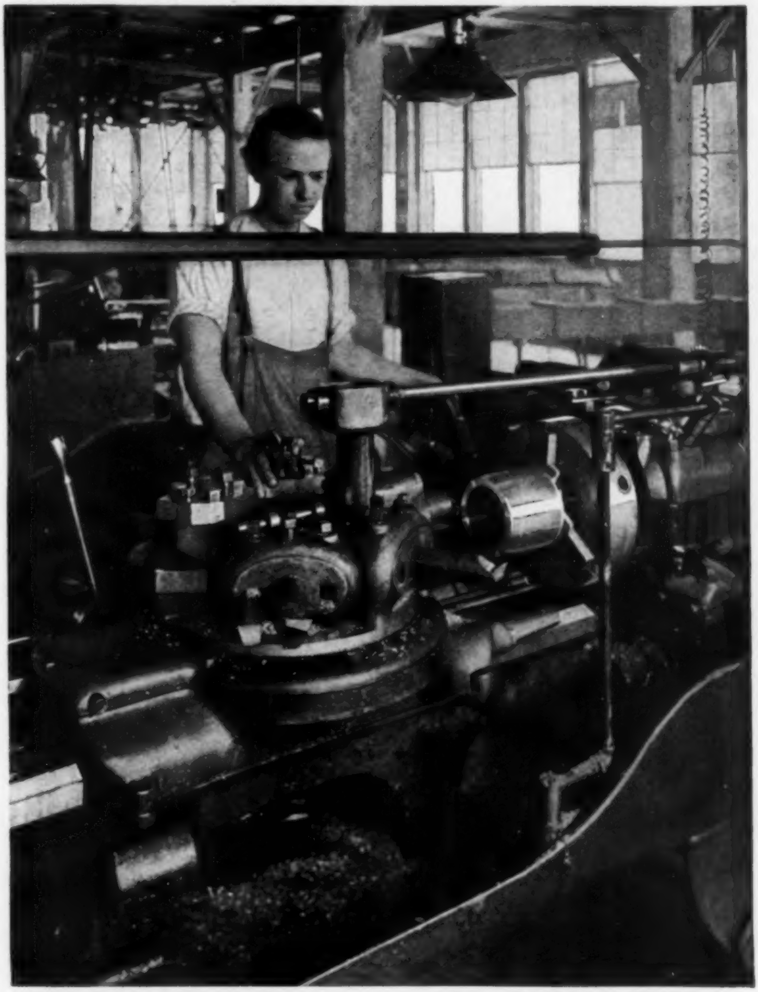
HARTNESS FLAT TURRET LATHE



These three views of the chasing tool show its use for three different kinds of work. In the top picture on opposite page it is cutting an inside screw thread and the lower cut illustrates the tool in position for chasing an outside thread.

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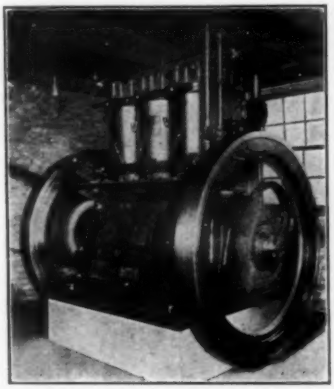

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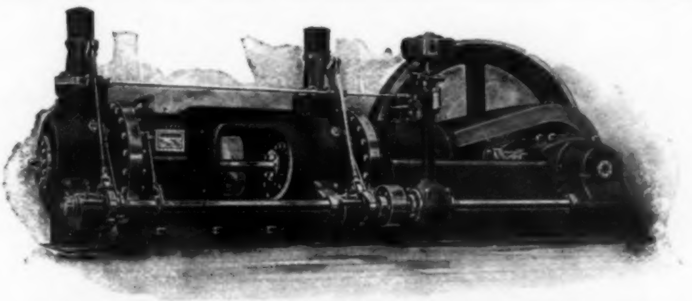

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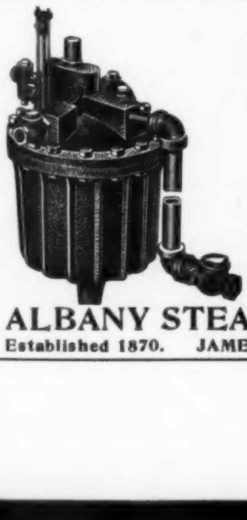

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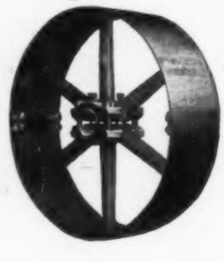

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SECTION 5

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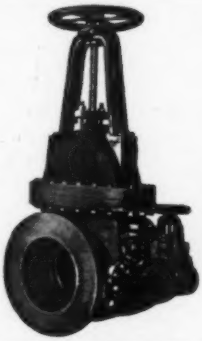

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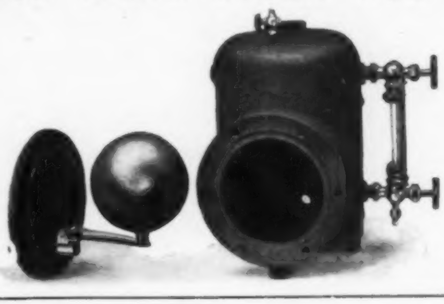

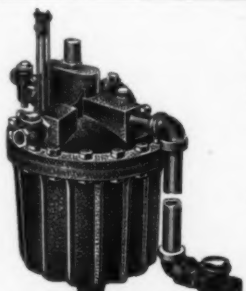

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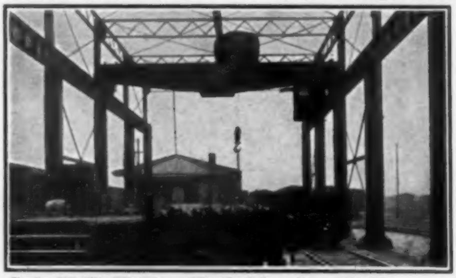

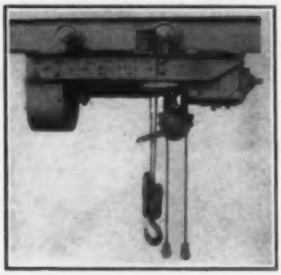

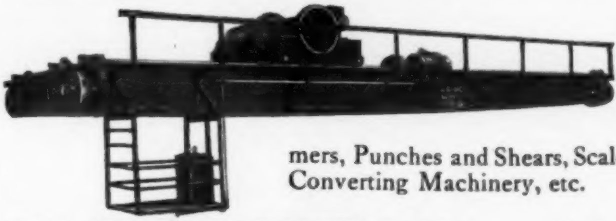

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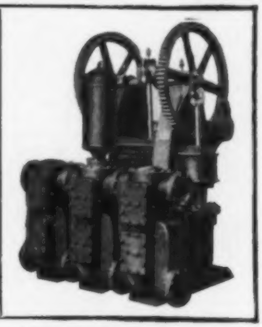

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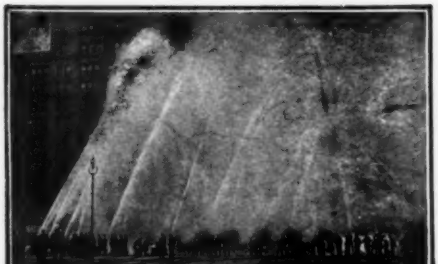

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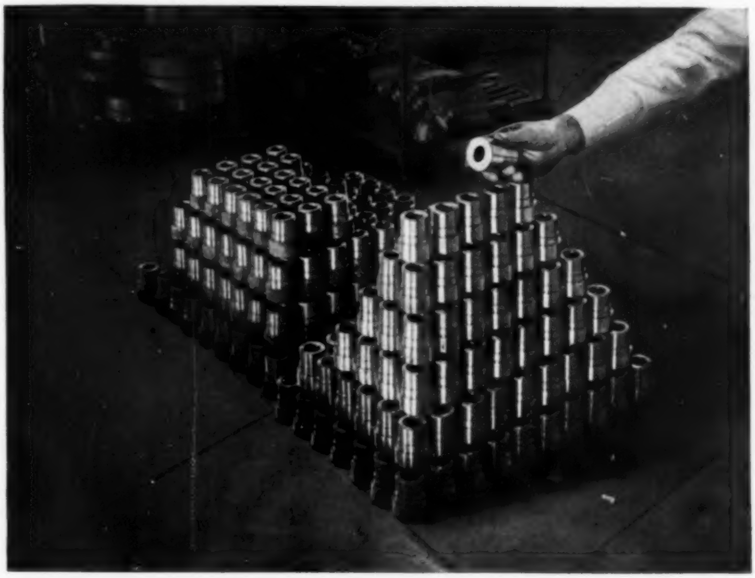

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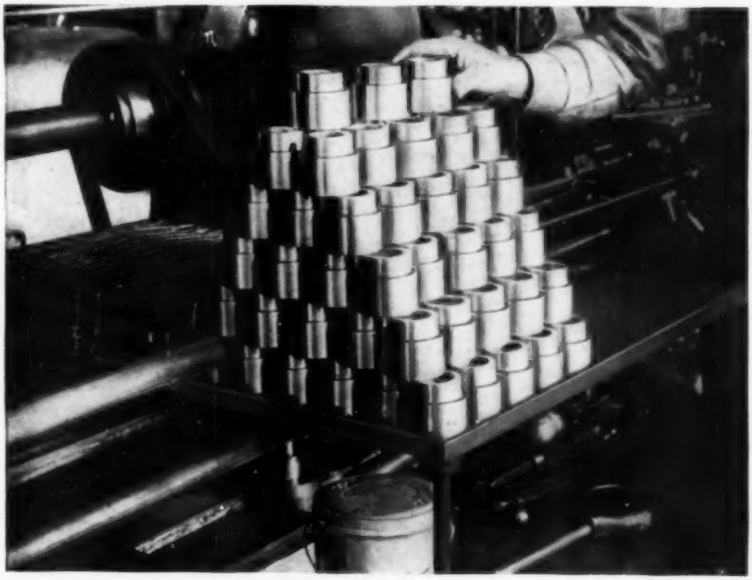

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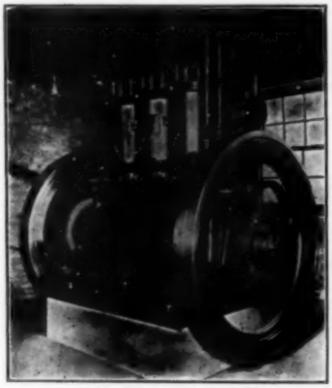

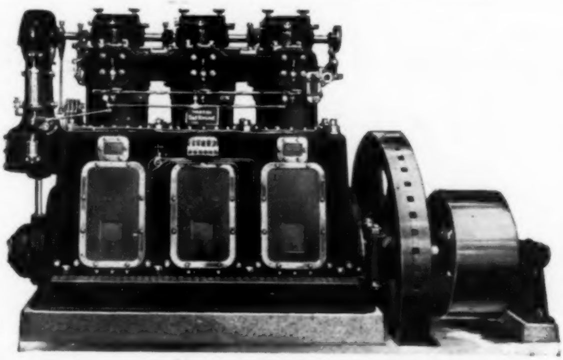

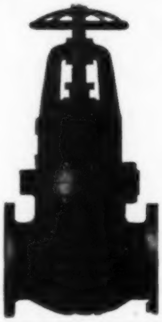

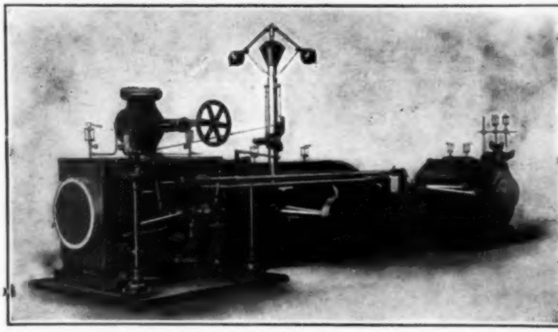

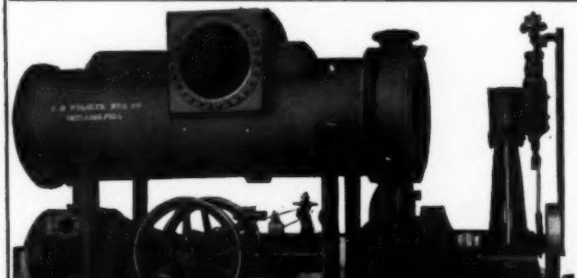

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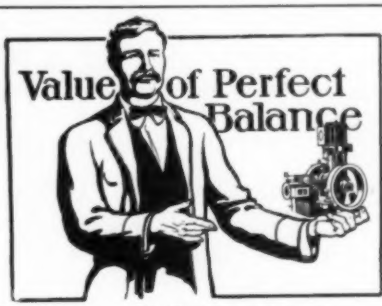

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SECTION 4

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SECTION 5

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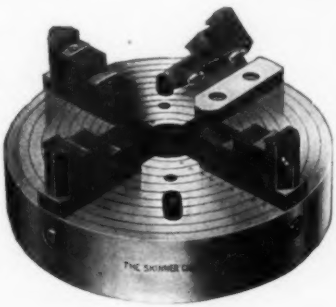

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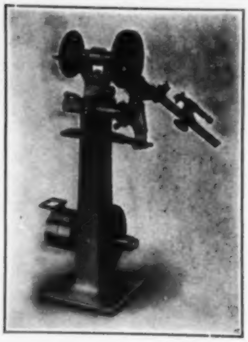

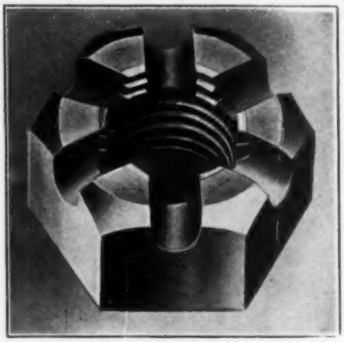

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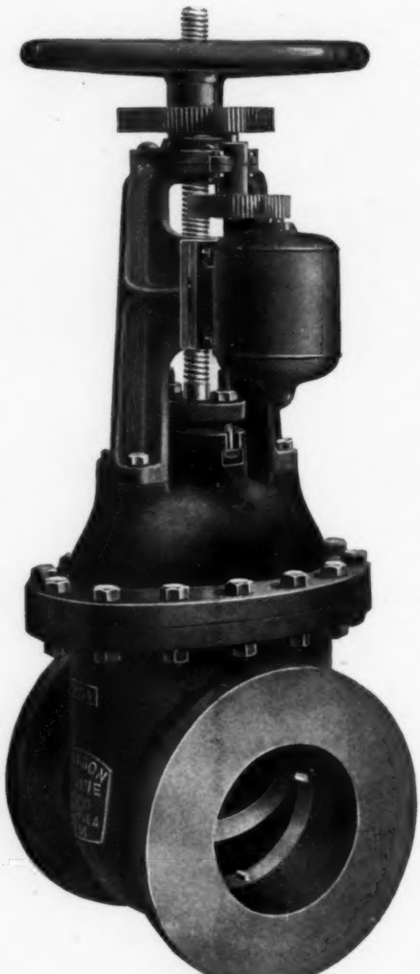

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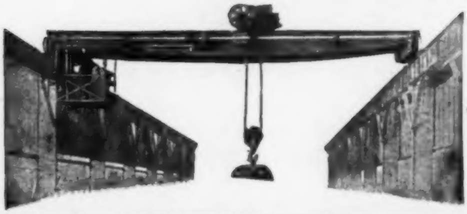

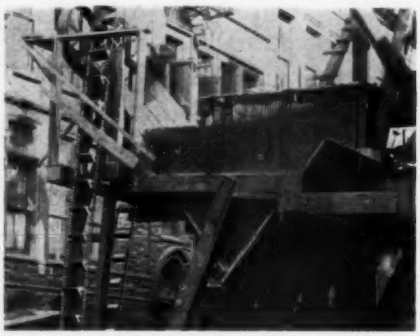

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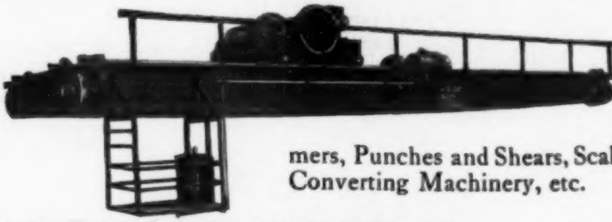

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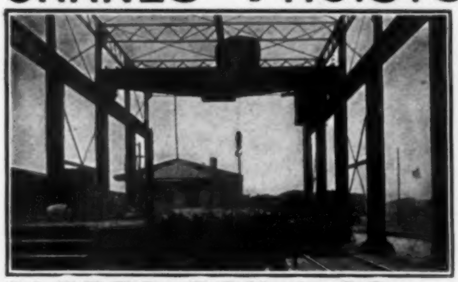

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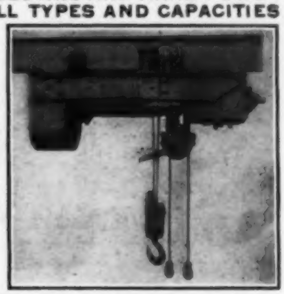

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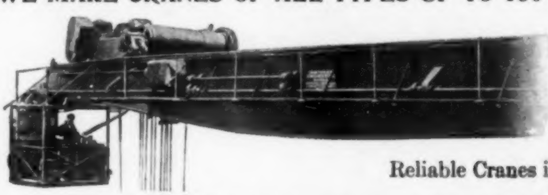

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